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Economic Comparisons for Harvesting, Storing, and Feeding Dry Forages to Beef Animals

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I. Introduction

The purpose of this study was to analyze the costs of harvesting, storing, and feeding dry forages for beef cows. The emphasis was upon large package hay machines and associated equipment. These machines have been available for less than ten years and gained popularity in the past five years. The harvesting of corn stover has enhanced their use.

The importance of finding more efficient ways to harvest, store and feed forages is illustrated by the 2.43 million acres and 6.98 tons of hay typically harvested in Iowa (16). In 1976 Iowa had 1.9 million beef cows (16). A winter feed supply is important to beef calf raisers and the cost of that supply often makes the difference between profit and loss. Finding cheaper methods of providing winter feed is not only important in itself but also may release labor to other productive activities and/or make the work more pleasant.

Harvesting hay crops traditionally has been a labor intensive, time consuming, and physically strenuous task. It was manually handled at least three times. The thirty years prior to 1970 were marked with few innovations. The self-knotting field pickup baler was introduced about 1940. Throughout the 1940's, 50's and 60's cutterbar mowers, sidedelivery rakes, and squarebale field pickup balers were the standard harvesting machines. Mower-conditioners and windrowers were introduced in the mid-1960's. A 1967 U.S.D.A. estimate of hay cutting in the corn belt states showed that 79 percent of all hay was cut with cutterbar mowers and 20 percent with mower-conditioners or windrowers (32); 96.7 percent was baled. Of the baled hay, 56 percent was loaded with a chute and trailing wagon, 29 percent was loaded from the ground onto the wagon by hand, 11 percent was loaded with a bale thrower, while only 4 percent was handled by other methods such as accumulators or mechanical bale wagons. Storage of square bales was in shelters, usually large barns, to prevent spoilage.

In the late 1960's and early 1970's, two revolutionary innovations in field hay packaging were introduced. The first innovation was the stack-forming wagon or stacker. This machine forms compact stacks of hay or corn stover. Most stackers pick up the windrow with a flail pickup and blow the hay into an enclosed wagon or chamber. The top of the chamber is hydraulically or mechanically lowered to compress the loose hay several times during stacking. When a full stack is formed, it can be discharged in the field for later transport to storage or it can be moved with the stacker and be discharged at the storage site. Stack weight depends on the material stacked and the machine's capacity. Types and sizes of stackers are now available to make stacks varying from one to eight tons (7). Common stack sizes are about 7 ft. wide, 8 ft. long, and 8 ft. high; 8 ft. wide, 14 ft. long, and 10 ft. high; and 8 ft. wide, 20 ft. long, and 12 ft. high.

The other packaging innovation was the large roll or round baler. These balers produce large cylindrical bales ranging from 800 lb. to 3,000 lb. There are two mechanical methods of forming the bale. One method picks up the hay from the windrow and rolls the hay in an interior chamber created by a series of belts. The other method rolls the windrow on the ground, similar to rolling up a carpet (8). The large round bales are wrapped around the outside with twine and dropped in the field as they are made. Three common sizes are 4 ft. in length and 2 1/2 to 5 ft. in diameter, 5 ft. in length and 2 1/2 to 6 ft. in diameter, and 6 ft. in length and 2 1/2 to 7 ft. in diameter.

The stacks and large round bales can be moved to and from storage by a tractor equipped with a three-point-hitch mover, a wheeled trail-type mover, or a front-end loader. Larger stacks must be moved with a wheeled trail-type mover. The stacks are rounded at the top so as to shed water for outdoor storage as do the round bales. Both stackers and large round balers can be used to harvest corn stover.

Advantages claimed for large hay packaging over conventional squarebale systems include the elimination of physical hay-handling drudgery, smaller work crews, and the elimination of the need for hay storage structures. The faster packaging rates of large package machines reduce the total haying time and potentially permit more hay to be harvested within the optimal yield and quality time range. Disadvantages claimed are higher machinery costs, potentially greater storage and feeding losses, and less marketability compared to square bales. New feeding techniques must also be learned (4,8,9,23).

II. Survey Procedures and Findings

Information about types, sizes, costs, and use was obtained from two sources; suppliers and users. A mail questionnaire was mailed to twelve manufacturers of stackers and large round balers. These were asked to give current sale price, recommended tractor size, estimated field capacity, variable operating costs, repair costs, and wear-out live. Also, they were asked to give the number of sales to date to gain information about farmer acceptance and availability. Visits were made to twenty-eight farmer-owners of stackers and large round balers. Names were supplied by county extension agents, machinery dealers, and local farmers. An effort was made to assure that common types and sizes of machines were represented and geographically distributed, particularly in the hay producing areas of Iowa. A review of literature also was incorporated into the analysis.

The sales information indicated that the most popular stackers were the one-ton and two-to-three-ton sizes, and that the most popular large round balers were the 1200 to 1800 lb. size. Sales information also indicated that most sales of large-package haying equipment were in Southwestern, Southeastern, and Northeastern Iowa. These three areas are also the three major hay regions of Iowa (16).

The distribution of farmers interviewed was:

(a) Southwestern Iowa
4 large round balers: all Vermer 605Cs.[1]
6 stackers: 4 Hesston StakHand 10s, 1 John Deere 100,
1 Hesston StakHand 30A.

(b) Southeastern Iowa
10 large round balers: 5 Vermeer 605Cs, 3 Vermeer 706Cs,
2 Hesston 5800s.
4 Stackers: 3 Hesston StakHand 10s, 1 Hesston StakHand 30A.

(c) Northeastern Iowa
4 large round balers: all Vermeer 605Cs
4 stackers: 3 Hesston StakHand 10s, 1 Hesston StakHand 30A.

Two farmers each owned two large round balers, one farmer owned both a large round baler and a stacker, and one farmer owned two stackers, making the twenty-eight owners represent thirty-two machines: fourteen stackers and eighteen large round balers.

Farmer experiences were based on two to five seasons of use. The average length of ownership for the twenty-eight farmers was three years. All of the farmers visited thought that the useful machine life (ignoring potential obsolescence) for both stackers and balers is at least ten years. Repair costs could not be estimated accurately from the interviews because the farmers had only a few years experience with the new machines, and the variability in repair bills was great. Estimates varied from zero to $300 per year. It did seem that large round balers had a more constant repair cost per year, while repairs for stackers were more variable from year to year.

Package weight depends on the type of hay material, moisture content, operator skill, and operator preference. Generally, the farmers credited the large-package machines with a lower package weight than did the manu-

[1]The use of commercial names is to help identify the machines and does not imply endorsement of these machines over those of other manufacturers.

facturers. Owners of Hesston StakHand 10s reported an average hay stack weight of 2,000 lbs. Corn stover stack weights varied from 1,000 to 2,000 lbs. The Hesston Company rates their Model 10 at 2,500 lbs. for hay. Hesston StakHand 30A owners reported hay stack weights from 3,000 to 4,500 lbs., whereas the Hesston Company rates the StakHand 30A at 6,000 lbs. The interviews indicated that Vermeer 605C bales weighed 1,200 to 1,500 lbs. The Vermeer Company rates the 605C model baler at 1,500 to 1,800 lbs. Vermeer 706C owners claimed that 706C bales weighed from 1,600 to 2,700 lbs. The Vermeer Company rates their 706C model baler at 2,500 to 3,000 lbs. Throughout the remainder of this study, Hesston StakHand 10 and similarly sized stackers will be referred to as "one-ton stackers," Hesston StakHand 30A and similarly sized stackers will be referred to as "two-ton stackers," Vermeer 605C balers and similarly sized balers will be referred to as "1,500 lb. round balers," and Vermeer 706C balers and similarly sized balers will be referred to as "2,500 lb. round balers." The names of different machines for each size and type are given in Table A1.

The 1,500 lb. round balers had packaging rates of twelve to fifteen bales per hour. Owners of 2,500 lb. round balers reported rates of eight to ten bales per hour. One-ton stackers stacked four to six stacks of hay per hour or four corn stover stacks per hour. Two-ton stackers stacked two to five stacks of hay per hour or three corn stover stack per hour. All of these rates are close to the rates suggested by the manufacturers. Packaging rates are affected by terrain, yields, hay conditions, and operator desire. Packaging rate and operator skill were thought to have the strongest effect on the soundness and quality of the package made.

Most farmers interviewed preferred to use a tractor with a cab as the source of power for their large-package machines because of dirt and hay dust in the field. Cabbed tractors are generally larger tractors in the 90 to 125 horsepower range.

Mowers and side-delivery rakes are still used to cut and windrow hay, but mower-conditioners and windrowers are becoming more prevalent. The twenty-eight farmers collectively owned ten mowers, eleven mower-conditioners, seven pull-type windrowers, three self-propelled windrowers, twenty-two side-delivery rakes, and twenty-four small square balers.

Ten of the thirteen stacker owners did custom work for other farmers. Thirteen of the sixteen large round baler owners did custom work. Custom rates from the interview were $3.50 to $4.50 per bale for 1,500 lb. bales, and $7.50 to $10.00 per stack for one ton stacks.

Nineteen of the twenty-eight farmers still make at least a small amount of hay into small square bales. These wished to use available covered storage or carry a reserve of small bales for small feeding jobs or for emergencies, such as bad weather, when large packages cannot be moved. Straw was often put into small bales for easier use or marketing. Corn stover packages were made by all of the stacker owners but by only one-half of the baler owners. The condition of the stover is more critical for baling than it is for stacking. Corn stalks must usually be cut with a stalk shredder or rotary scythe and raked into windrows for baling.

Large hay packages are designed to be stored outside. The types of hay usually grown were alfalfa, alfalfa-orchardgrass and alfalfa-bromegrass. Of the twenty-eight farmers interviewed, fifteen stored their hay at a central location, thirteen stored their hay in the field, and two stored the packages inside buildings. Two farmers used two methods. The twenty-eight farmers' estimates of large-package weight loss due to weathering are shown in Table 1. By comparison, Parsons, Petritz, and Lechtenberg (24) reported a weight loss due to weathering of 5 to 6 percent above the normal weight loss of hay in covered storage. Weather deterioration was confined to the outside 2 to 4 inches of large round bales and the top 4 to 5 inches of stacks. All of the farmers interviewed were confident that storage and weathering losses are relatively small.

Table 1. Weight loss due to weathering estimates by the twenty-eight farmers interviewed.

Type of package and location	Percent Weight Loss Less than 5	 5 to 10	 11 to 20	Average thickness of weathered top
	Number of farmers reporting			
Large Bales				
S.W. Iowa	3	1	0	3 inches
S.E. Iowa	2	4	1	3 inches
N.E. Iowa	2	2	0	2 inches
Large Stacks				
S.W. Iowa	4	1	0	2 inches
S.E. Iowa	0	3	1	2 inches
N.E. Iowa	2	2	0	3 inches
Total	13	13	2	

Only three dairy farmers were interviewed, one in each area. Northeastern Iowa has many dairy farmers, but comments indicated that most dairy farmers prefer to use either haylage or barn-stored small bales to keep feed quality high. Dairy cows tend not to eat the spoiled material in large packages, while beef cattle will. All other farmers interviewed had beef cow herds. Nine farmers also used large packages to feed feeder cattle. Seventeen owners fed corn stover stacks to their beef cow herds. The ratio of corn stover packages to hay packages fed varied from 2:1 to 1:1 to 1:2. Table 2 gives the methods of feeding the packages to beef cows.

Generally, those interviewed used racks in the field for cows and racks in the lot for feeder cattle. Few farmers fed without racks, and no one used such methods as unlimited open grazing of packages or moving a feeding fence along the storage area. Scattering small bales across the field was the common feeding method previously used by the twenty-eight farmers interviewed.

Table 2. Methods of feeding large packages to beef cows by twenty-eight farmers interviewed.

Types of package and location	Racks in field	Racks in lot	Racks not used
Large Bales	Number of farmers reporting		
S.W. Iowa	3	2	2
S.E. Iowa	6	3	0
N.E. Iowa	2	2	1
Large Stacks			
S.W. Iowa	4	4	2
S.E. Iowa	3	2	0
N.E. Iowa	2	1	1
Total	20	14	6

Most of the farmers thought that feeding losses were less than 5 percent, as shown in Table 3.

Table 3. Feeding wastes estimated by the twenty-eight farmers interviewed.

Type of package and location	Percent Wasted		
	Less than 5	5-10	10-20
Large Bales	Number of farmers reporting		
S.W. Iowa	1	2	1
S.E. Iowa	4	2	1
N.E. Iowa	4	0	0
Subtotal	9	4	2
Large Stacks			
S.W. Iowa	5	0	0
S.E. Iowa	2	1	1
N.E. Iowa	4	0	0
Subtotal	11	1	1
Total	20	5	3

Lechtenberg, Smith, Parsons, and Petritz (20) estimated wastes for hay fed in a rack on concrete as 3.7 percent by weight, and a rack on pasture as 4.7 percent by weight. Most farmers estimated that feeding waste from corn stover stacks was 20 to 25 percent.

The quality of hay in large packages was considered as good or better than small bales stored outside. Lechtenberg, Smith, Parsons, and Petritz (20) reported that hay in the unweathered core portion of the large hay package is of comparable quality to hay packaged in conventional bales and barn stored. When comparing stacks for quality of storage with large bales, the farmers interviewed could not agree on quality differences. Experience with hay packages carried over into a second winter season was limited. Farmers generally tried to avoid having large-package hay carryover.

The large balers were generally considered faster than the stackers. Large bales were considered slightly easier to handle, transport, and market. Large balers are not considered to work as well as stackers for packaging corn stover.

The reasons given for adopting the large package systems were:

(a) Less physically strenous labor was required both during summer harvesting and winter feeding.

(b) Less time was spent haying and feeding.

(c) More of the hay crop could be harvested at the optimal growth stage for quality and yield.

(d) The systems eliminated the need for hired labor. Most all farmers agreed that good workers were hard to find and costly to hire.

(e) The systems eliminated the need for flat wagons, bale elevators, and storage buildings.

III. Procedure for Machinery Cost Analysis

Machinery costs are composed of fixed, or ownership, costs and variable, or operating, costs. The fixed costs include depreciation, interest on investment, sales and property taxes, insurance, and housing. The variable costs are labor, fuel, oil and filters, repairs, maintenance, and twine. Investment credit and tax deductions for interest paid on machinery debt and for depreciation reduce the total income taxes of the machine owner. This tax savings can be considered a reduction of annual ownership costs and should be calculated as such. The value of yield losses from untimely operations due to limited machine capacity can also be considered when analyzing machine costs; however, hay quality loss occurs before actual tonnage loss. The value of quality loss is difficult to measure.

To calculate these costs at different levels of use, a FORTRAN computer program was used. This program was developed by Dr. George E. Ayres, Extension Agricultural Engineering, Iowa State University, and modified to include tax savings cost reductions by Dr. Craig V. Fulton, formerly of the Center for Agricultural and Rural Development. The program computes fixed cost components for each year. These costs for each year were discounted to present equivalent values, summed for all years, and multiplied by a capital recovery factor to find annual equivalent costs.

Purchase prices for the various machines included in the analysis are shown in Table A4. These are manufacturer's suggested list prices as of fall, 1976.

Depreciation. Depreciation was calculated by using four farm value equations in the Agricultural Engineers Yearbook (1):

(a) Group 1 implements Percent = $64(0.885)^n$
(b) Group 2 implements Percent = $60(0.885)^n$
(c) Group 3 implements Percent = $56(0.885)^n$
(d) Tractors Percent = $68(0.920)^n$

Group 1 implements include the racked wagons, mower-conditioners, and windrowers. Cutterbar mowers and side-delivery rakes are group 2 implements. Conventional small square balers are group 3 implements. These equations express the remaining on-farm values of a machine for the end of a year n as a percentage of the initial list price of the machine. Remaining on-farm values were computed by multiplying the percentage times the list price of the machine. Thus, the difference between the list price and the remaining farm value was the amount of depreciation. The ownership period of the machines was assumed to be either seven years or ten years. A machine with a useful life of at least seven years is eligible for the full investment credit. The ten year ownership period is the traditional useful life used in most economic and engineering studies. Windrowers and mower-conditioners were assumed to have a seven year life. All other machinery was assumed to have a ten year life. Since the new stackers and large balers are not known to fit into any of the four implement groups, 10 percent was used as a salvage value percentage.

Interest on Investment. The interest rate used was the market loan rate of 9 percent. A more appropriate rate would be the opportunity cost of capital representing the return on alternative investments. It was assumed in this study that 9 percent reflected the opportunity cost of capital, or that most machinery purchases were debt financed, in which case it is an actual cost of ownership.

The annual combined cost of interest and depreciation was tabulated using a capital recovery method expressed as an "annual equivalent cost (AEC)." This method combines the repayment of depreciation and the return on the investment during the machine's life into a series of equal annual payments at compound interest (15). The mathematical expression used was (30, pp. 47, 94):

$$AEC = B(a/p)_n^i - V(a/f)_n^i$$

where

AEC = annual equivalent cost
B = initial cost or price of the machine
V = salvage value at the end of the n-th year
i = interest rate
n = number of years
$a/p = i(1 + i)^n/[(1 + i)^n - 1]$ a uniform series worth of a present sum or capital recovery factor
$a/f = i/[(1 + i)^n - 1]$ a uniform series worth of a future sum or a sinking fund factor.

This technique finds the annual equivalent of the initial cost less an annual equivalent of the salvage value.

Taxes and Insurance. The sales tax in Iowa is 3 percent of the purchase price of a machine or the "boot" portion if there is a "trade-in." In this study, all machines were assumed to be purchased new. Their purchase price was the suggested retail list price. The sales tax, freight, and set-up charges were excluded and were assumed equal to a cash discount or trade-in allowance of 4 to 5 percent. Property taxes on farm machinery are scheduled to be phased out in Iowa by 1983. The current average tax rate in Iowa is about 2.16 cents for $100 of assessed value, and the assessed value is now 100 percent of estimated market value at the beginning of each year (3).

Most farmers purchase property insurance for their major machinery to allow for replacement in case of a natural disaster such as a fire or wind storm. Current rates for farm machinery insurance in Iowa range from $6.00 to $10.00 per $1,000 of valuation.

Annual taxes and insurance costs were lumped together as .8 percent of the remaining machine value at the beginning of each year. The annual costs were discounted and then summed to find the present value. The present value figure was multiplied by the capital recovery factor to find the annual equivalent cost of taxes and insurance.

Housing. Housing, tools, and maintenance equipment for machinery can result in fewer repairs, less deterioration of parts, higher reliability in the field, and a higher trade-in value. The costs of providing housing and maintenance facilities should be charged to the machine, or an extra charge for the increased repair costs of machinery not protected should be made. In this study, annual housing costs were 2 percent of the list price or original cost of the machine. This includes part of the cost of tools and a farm shop. The housing cost was expressed as a percentage of original cost because it should not change over the life of the machine. Since the housing cost was the same each year, the annual equivalent cost of housing was the annual cost.

Repairs and Maintenance. Repairs and maintenance costs were estimated from a series of equations developed by Bowers (7). The equations estimated the total accumulated repair costs for the different types of machinery. The repair costs included all parts and labor, whether the repairs are made in a commercial shop or on the farm. The general form of the total repair cost equations is:

$$TAR = ILP \times RC1 \times RC2 \times L^{RC3}$$

where

TAR = total accumulated repair costs estimated at "L"
L = percent of wear out life of the machine when accumulated repair costs are estimated
ILP = initial list price of machine
RCL = a constant that expresses the ratio of TAR to ILP at L = 100 percent.

RC2 and RC3 are constants that determine the shape of the accumulated repair cost curve for any specific machine. For all equations the value of the expression RC2 x L^{RC3} will equal one when L equals 100 percent. These equations assume that there is no inflation on parts and labor.

The equations used in this study and the wear out life in hours of the machines in this study are given in Tables A2 and A3.

The cost of repairs and maintenance were calculated for each year. These costs were discounted and then summed to find the present value of repair and maintenance costs. This figure was multiplied by the appropriate capital recovery factor to find the annual equivalent cost of repairs and maintenance.

Fuel, Oil, and Filters. In this study, fuel costs were estimated by one of two methods. The first method used Persson equations for fuel consumption (1). The equations are based on the maximum equivalent PTO horsepower of the engine, equivalent PTO horsepower being used, maximum governed engine RPM, and the engine RPM being used. The equation for diesel engines is (1):

Fuel consumption in gals/hr. =

$$.047[1 + .37\{(\frac{\text{Actual RPM}}{\text{Max RPM}})^2/\frac{\text{Actual PTOHP}}{\text{Max PTOHP}}\}] \cdot \text{Actual PTOHP}$$

The equation for gasoline engines is (1):

Fuel consumption in gals/hr. =

$$.059[1 + .51\{(\frac{\text{Actual RPM}}{\text{Max RPM}})^2/\frac{\text{Actual PTOHP}}{\text{Max PTOHP}}\}] \cdot \text{Actual PTOHP}$$

These equations were used to calculate fuel consumption for all machine operations except transporting of hay or stover which requires no PTO engine power. For hauling operations, the diesel engine ASAE method was used (27). This method is based upon the PTO horsepower of the tractor. The method determines the average fuel usage of tractors in gallons per hour. The ASAE average fuel use formula for diesel engines is (27):

PTO hp x 0.044 = fuel consumption in gals/hr.

In this study, all tractor engines were assumed to be diesel engines. Self-propelled windrowers were assumed to have gasoline engines. The prices for gasoline and diesel fuel were $0.43 and $0.39 per gallon, respectively. These prices were averages for several points in Iowa in September of 1976. Taxes were subtracted off the gasoline price. Engine oil and filter costs were estimated at 15 percent of fuel costs. Transmission oil, filters, and other lubricants, such as grease, were included with the repair and maintenance costs.

Labor. Labor cost in hay harvesting and handling is the most critical of all variable costs. Different sizes and types of machines and different systems require different quantities of labor to accomplish the same task. As the wage rate changes (all else constant), the total cost comparative advantage or disadvantage of one machine or system compared to another will change. To determine the effect of different wage rates on machinery costs, total machinery costs were calculated using several different wage rates. Wage rates used were $0, $3, $5, $10, $15, $20, and $30 per hour. While actual wages may not be as high as $20 or $30 per hour, a farmer's opportunity cost for his own labor time may be this high or higher during peak seasons.

The actual man-hours of labor needed for a task will usually exceed the actual field time by 10 to 25 percent because of the time required to prepare and service machinery, and the travel time to and from the field. Hence, the labor cost per hour of field time will range from 110 to 125 percent of the hourly wage rate. In this study, labor time was assumed to be 110 percent of field time. If an operation required two workers simultaneously, a factor of 220 percent of field time was used.

Income Tax Savings. Tax savings were calculated for certain fixed or ownership costs and are an annual fixed amount. Tax savings were calculated for interest paid on debt, depreciation, and investment credit. In effect, these savings in taxes represent a reduction in ownership costs of machinery to the farmer.

It was assumed that machines were financed 60 percent through debt capital and 40 percent through equity capital. The interest rate for debt capital was the same as it was for interest on investment, 9 percent. The debt was paid off in four equal principal payments plus annual interest. The interest paid each year was a tax deductible expense.

Three methods can be used to determine machinery depreciation for tax purposes. All three methods were presented in this study to provide for comparisons among methods. The most common method used by farmers is the straight-line method; it will be referred to most often. The other two are the declining-balance and sum-of-the-years-digits methods (34). An additional first-year depreciation allowance can be taken on new or used machinery that has a useful life of six years or more when purchased. The current allowance was 20 percent of purchase cost. The first-year additional depreciation was subtracted off before calculating the annual depreciation for tax savings.

Since 1975, the investment credit has been 10 percent of the eligible basis (initial list price or list price less trade-in). Since it was assumed that only new machinery was purchased and that there was no trade-in, the basis for investment credit was the initial list price. The investment credit was subtracted from the income tax liability; it is a direct tax credit or savings and not a deduction from taxable income.

The marginal tax rate was assumed to be 36 percent (28 percent federal and 8 percent state income tax). This would be the marginal tax rate for farmers filing a tax return with a taxable income of $16,000 to $20,000.

The marginal tax rates were multiplied times the interest paid on debt for each year, the first-year additional depreciation, and the annual depreciation to calculate the tax savings. The annual equivalent values for each of these items and the investment credit were calculated. The annual equivalent values for investment credit, interest paid on debt, and first-year additional depreciation were added to the annual equivalent value calculated for each depreciation method to obtain the annual equivalent value of tax savings. They were individually subtracted from the total annual fixed costs of the farm machinery.

MACHINERY SYSTEMS AND OPERATING RATES

Harvesting and handling hay involves four basic steps: cutting and windrowing, packaging, handling into storage, and handling out of storage or feeding. The following systems were tabulated.

Cutting and windrowing systems

1) Conventional seven-foot cutterbar mower and a nine-foot side-delivery rake. Both were powered by a 60 hp tractor.

2) Conventional nine-foot cutterbar mower and a nine-foot side-delivery rake. Both were powered by a 60 hp tractor.

3) Ten-foot mower-conditioner with windrow-forming shields powered by a 70 hp tractor.

4) Twelve-foot pull-type windrower powered by a 70 hp tractor.

5) Fourteen-foot pull-type windrower powered by a 70 hp tractor.

6) Twelve-foot self-propelled windrower powered by a 65 hp gasoline engine.

7) Fourteen-foot self-propelled windrower powered by a 65 hp gasoline engine.

The unit measurement of cost for cutting and raking hay was dollars per acre. Hay cut with conventional cutterbar mowers required raking with each cutting. For the windrowers, no raking was assumed to be needed.

Packaging systems

The form in which hay is packaged determines the methods by which it can be handled, stored and fed. Therefore, it is necessary to analyze the complete system of packaging, storing, and feeding when selecting a forage packaging system. Storing and feeding systems were given for each packaging method. The packaging methods were:

1) Conventional square baler with extension chute. Bales were manually stacked on flat wagons pulled behind the baler. The rate of packaging and loading was 5 tons per hour. The operation required one man to operate the tractor and baler, and another man to stack the small bales on the wagon. The tractor was assumed to be 60 hp, although only 30 hp is required.

2) Conventional square baler with bale thrower. Bales were randomly loaded by the mechanical thrower onto racked flat wagons pulled behind the baler. The rate of packaging and loading was 5.25 tons per hour. The operation required one man to operate the tractor and baler. The tractor was assumed to be 60 hp, although only 45 hp is required.

All bales were manually placed into storage buildings using a portable bale elevator powered by an electric motor. The operation required one man to haul the bales from the field to storage and to unload the wagons. Two men were needed to stack the bales in the storage building. The men storing the bales could keep up with the baler. The small bales were fed by manually loading the hay onto the racked wagons and randomly scattering the bales in the field. At each tonnage, it was assumed that enough hay is hauled each day of a 120 day winter feeding period to exhaust the supply. The rate of feeding was .8 tons per hour; the operation was assumed to require only one man.

3) One-ton stacker. This machine makes a compressed stack of approximately 2,000 lbs. The packaging rate was assumed to be five tons per hour for hay and four tons per hour for corn stover. The operation required one man to operate the tractor and stacker. The tractor was assumed to be 120 hp, although only 40 hp is required.

The stacks were removed from the field and placed either in a central storage yard assumed to be .25 miles from the field or along the edge of the field. For central storage the rate of storage was four tons per hour and the rate of feeding was three tons per hour. For field storage, the rate of storage was six tons per hour and the feeding rate of 4.5 tons per hour. Costs were calculated using a three-point-hitch stack mower with a 95 hp tractor and a wheeled-trailer stack mower with a 60 hp tractor. One man was required.

4) Two-ton stacker. This machine makes a compressed stack of approximately 4,000 lbs. The packaging rate was assumed to be eight tons per hour for hay and six tons per hour for corn stover. The operation requires one man to operate the tractor and stacker. The tractor was assumed to be 120 hp, although only 60 hp is required.

The stacks were removed from the field and placed either in a central storage yard assumed to be .25 miles from the field or along the edge of the field. For central storage, the storage rate was eight tons per hour and the feeding rate was five tons per hour. For field storage, the storage rate was twelve tons per hour and the feeding rate was 7.5 tons per hour. One man, a 70 hp tractor, and a two-ton stack mover were required.

5) 1,500 lb. round baler. The baler makes a cylindrical bale weighing approximately 1,500 lbs. The rate of packaging hay was nine tons per hour. The operation required one man and a tractor. The tractor was assumed to be 120 hp, although only 45 hp is required.

The bales were removed from the field and placed either in a central storage yard assumed to be .25 miles from the field or along the edge of the field. For central storage, the storage rate was 3.2 tons per hour and the feeding rate was 2.3 tons per hour. For field storage, the storage rate was 4.8 tons per hour and feeding rate was 3.5 tons per hour. One man, a 70 hp tractor, and a three-point bale mover were required.

6) 2,500 lb. round baler. The baler makes a cylindrical bale weighing approximately 2,500 lbs. The rate of packaging hay was 12.5 tons per hour. The operation required one man and a tractor. The tractor was assumed to be 120 hp, although only 60 hp is required.

The bales were removed from the field and placed either in a central storage yard assumed to be .25 miles from the field or along the edge of the field. For central storage, the storage rate was eight tons per hour, and the feeding rate was 5.7 tons per hour. For field storage, the storage rate was 4.8 tons per hour, and the feeding rate was 3.5 tons per hour. One man, a 95 hp tractor, and a bale mover were required.

The assumed tractor sizes and power requirements are summarized in Table A4 with price lists previously cited. The haying operations, performance rates, and manpower requirements are summarized in Table A5. Restated, the basic assumptions for this cost derivation are:

1) Economic machinery life is seven years for cutting equipment, 10 years for all other machinery.

2) The cost of invested capital is 9 percent.

3) The cost of taxes and insurance together is .8 percent of the on-farm value of a machine at the beginning of each year.

4) The cost of housing and service facilities is 2 percent of the original purchase price of a machine per year.

5) Gasoline price, after tax credit, is $.43 per gallon. Diesel fuel price is $.39 per gallon. Lubrication costs are 15 percent of fuel costs. All tractors have diesel engines. All self-propelled windrowers have gasoline engines.

6) Labor time is 110 percent of field or machine time. Labor cost or wage rate is varied from zero to $30 per hour.

7) Twine cost per 1,500 lb. round bale is $.25 and per 2,500 lb. round bale is $.30. Twine cost is $.03 per bale for a small square bale.

8) Performance rates for packaging, storing, and feed are estimated in tons per hour.

9) Performance rates for cutting and windrowing are estimated in acres per hour.

IV. Results of Cost Analysis

Using the input data, assumptions, and equations given in the previous section, the following were calculated for each operation:

a) total annual equivalent fixed cost,

b) total annual equivalent fixed cost less the total annual tax savings for each of the three depreciation methods,

c) average repair costs per ton for different annual tonnage levels,

d) average variable costs per ton for different annual tonnage levels,

e) average fixed costs per ton for different annual tonnage levels,

f) average total costs per ton for different annual tonnage levels,

g) average total costs per ton net of tax savings for different annual tonnage levels.

Variable costs such as fuel, lubricant, labor, and twine are constant per ton. However, repair costs as used in this analysis increase with the tons of annual use. This primarily is because a fixed life span in years was assumed with an increasing repair cost function per unit of increased use. Thus, the average repair cost per unit of use increases as the annual use becomes larger. The total annual fixed cost is not affected by the annual amount of use. Thus, the per unit value of average fixed costs decline as the tonnage use increases. The decrease in fixed costs per ton usually more than offsets the increase in per unit repair costs. As the tonnage use increases, however, the decrease in total costs per unit is much smaller, because the variable costs constitute an even larger proportion of the total costs.

Table 4 shows the annual equivalent fixed cost (AEFC) and fixed costs net of tax savings (AFCN) for each machine. AEFC include the fixed costs previously defined after discounting them to the present and before adjustment for income tax savings. AFCN include an adjustment for income tax at previously stated levels. (See page 9 for an explanation of discounting procedures.) Appendix Tables B1 through B5 give repair, variable, fixed, and total costs per unit of use for increasing acreage or tonnage levels for each machine and operation and for all operations combined.

From the tables, using the total cost columns, average total cost curves were plotted as illustrated in Figure 1. For any given tonnage, the system with the lowest curve is the least-cost system. Changing the cost of any one variable, as was done with labor, will cause the curves to shift by differing proportions. The system that is least-cost at a given level may not have been under the previous wage rate assumption. By determining least-cost systems at different usage levels and different wage rates, a least-cost map was derived showing for each combination of wage rate and tons harvested the least-cost system. Figures 2 through 11 show these mappings. Solid lines divide the graphs into areas within which different systems are least-cost. Since only specific wage rates were considered, the lines connecting the results obtained at these levels approximate results for the rates other than those actually evaluated. The lines separating the least-cost systems are upward sloping to the left. This indicates that as the opportunity cost of labor (or wage rate) increases, systems which are less labor intensive become least-cost at lower levels of annual use.

When comparing the figures for least-cost systems against the figures for least-cost systems net of tax-savings, it can be seen that the lines shift to the left. The tax-savings allows the more expensive windrowers and large-package machines to become least-cost at lower levels of annual use.

Table 4. Annual equivalent fixed costs (AEFC)

	AEFC	Fixed cost net of tax savings Straight-line	Double-declining balance	Sum-of-the-years digits
1500 lb rd baler	$907.42	$596.54	$592.66	$577.41
2500 lb rd baler	1169.18	768.62	763.62	743.98
One-ton stacker	1291.80	848.92	843.40	821.71
Two-ton stacker	2006.80	1319.27	1310.69	1276.98
Square baler	759.09	499.02	495.78	483.03
Sq. baler/with b. thrower	926.43	610.49	593.51	591.91
7 ft mower	191.33	126.33	122.32	122.54
9 ft mower	209.79	138.52	134.13	134.36
10 ft mower-conditioner	870.51	547.41	525.45	534.96
12 ft pull-type windrower	1296.09	815.03	782.33	796.49
14 ft pull-type windrower	1334.78	839.36	805.69	820.27
12 ft self-propelled windrower	2127.91	1338.10	1284.43	1307.68
14 ft self-propelled windrower	2205.29	1386.76	1331.13	1355.23
Side-delivery rake	209.79	138.52	134.13	134.36
Flat wagons (two)	267.56	86.46	74.06	76.00
Racked flat wagons (two)	334.44	108.06	92.58	94.98
Bale elevator	139.60	91.77	91.18	88.83
1500 lb baler mover	31.42	9.90	9.62	8.58
2500 lb bale mover	174.50	54.92	53.44	47.58
One-ton, three-point stack mower	130.88	41.20	20.04	35.68
One-ton, trailer stack mover	214.64	67.56	65.74	58.52
Two-ton stack mover	549.68	173.04	168.34	149.86

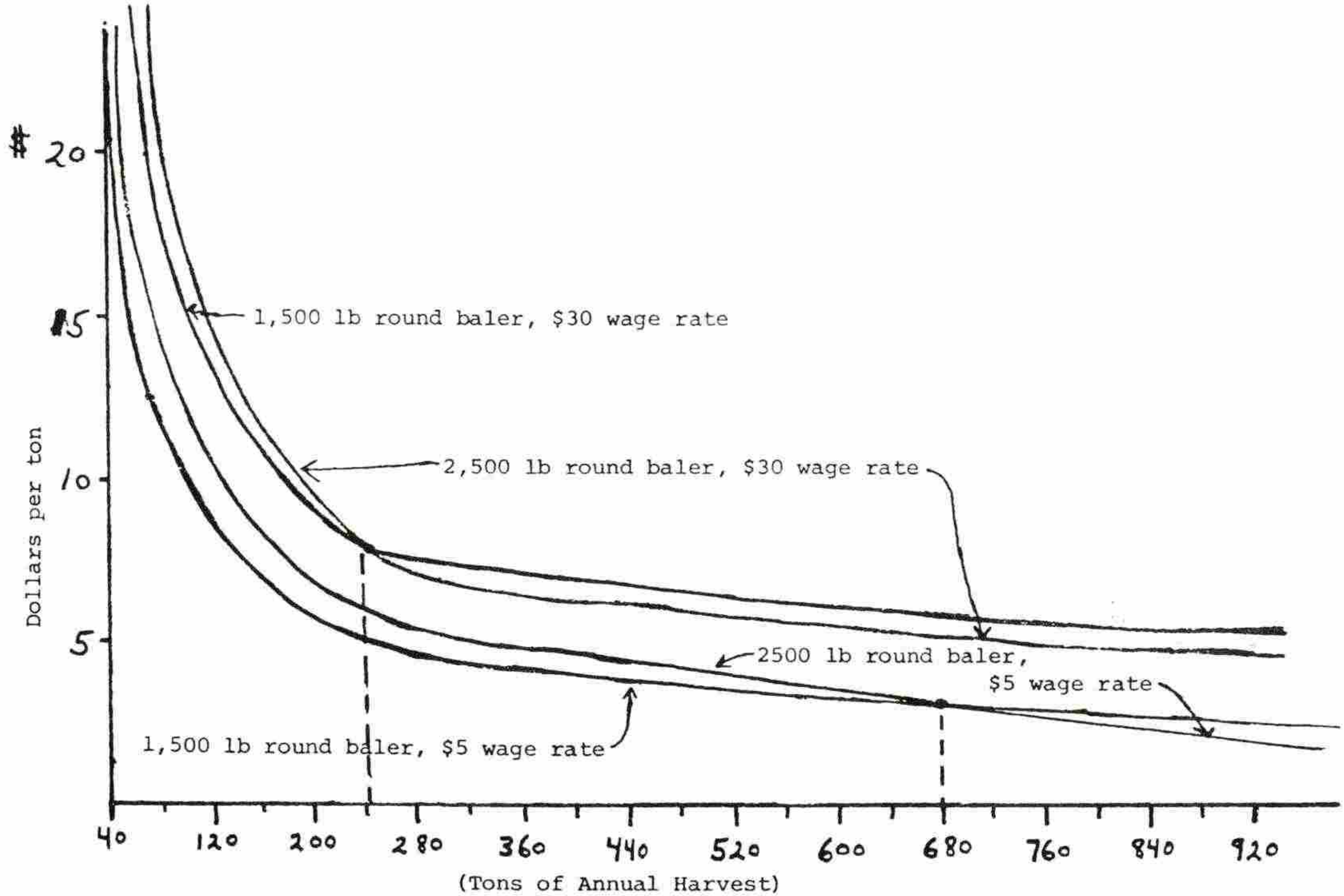

Figure 1. Example of machinery cost curves at $5 and $30 wage rates

Figures 2 and 3 show least cost systems for cutting and windrowing hay over increasing acres (tons) and wage rates. Acres of annual use were determined by multiplying the acres of forage times the number of harvests per year. Figure 3 shows adjustments as a result of tax savings. The 7-foot mower is least-cost only at acreages less than 120 and wage rates of 10 dollars without tax savings and 5 dollars net of tax savings. The 9-foot mower is least-cost at all acreages and wages rates below about 4 dollars. At wage rates of 10 dollars the 14-foot pull-type windrower became least-cost at 270 acres without tax savings and 180 acres net of tax savings. Self-propelled windrowers were not competitive at any acreage and wage rate combination primarily because of their relatively high fixed costs.

Figures 4 and 5 show least-cost figures comparing all six packaging systems. Costs include packaging, hauling, and feeding of hay only. Other forages were not included. Figures chart least-cost systems at varying tons of harvested hay and labor wage rates. First it is apparent that at no levels of use and wage rates did conventional square balers or one-ton stackers show cost advantages over round balers or the two-ton stacker. The 1500 lb. round baler showed cost advantages over a large range of tonages at wage rates below \$3 but above \$3 the 2500 lb. round baler showed cost advantages beginning at 240 tons. The two-ton stacker showed cost advantages only at very high wage rates and levels of use.

Figures 6 and 7 compare only the three smaller systems - one-ton stackers, 1500 lb. round balers and small conventional square balers. The latter could not compete cost wise with the larger package machines and hence are not shown. The one-ton stackers, even when not in competition with two-ton stackers, or 2500 lb. round balers, are not shown to be very competitive with 1500 lb. round balers. They become least-cost only at high rates of use and wage rates. Tax savings tend only to lower these rates but do not change the relationships.

Figures 8 and 9 compare only stackers and small conventional square balers. Round bales were not considered. In this comparison, and for the first time, conventional balers showed cost advantages at tons of use below 280 and wage rates below 5 dollars without tax savings and 240 tons and 3 dollars with tax savings included. Next were one-ton stackers showing advantage over two-ton stackers until levels of use reached relatively high levels or high wage rates. For example, at a wage rate of 10 dollars two-ton stackers become least-cost at 280 tons without tax savings and 160 tons with tax savings.

Figures 10 and 11 show an expanded use for stackers by including other harvested forages, primarily corn stalks, in their comparisons. These figures were arrived at by partitioning the fixed costs and charging hay for only 67 percent of the total. Thus these figures only represent the hay harvest proportion of the total. The effect is to make the stackers less expensive per unit of use and thus more desirable for farmers with smaller acreages of hay and in comparison with other systems. All six systems are included in the comparisons but the conventional square balers were not competitive. At 3 dollar wage rates the 1500 lb. round balers harvested hay cheaper than any other system without tax savings and to about 200 tons with tax savings. At levels of use below 200 tons the one-ton stacker showed some advantage. Without tax savings the 2500 lb. round baler was cheaper to use than the 1500 lb. round baler at wage rates above 3 dollars and the two-ton stacker below 10 dollars. Considering tax savings the two-ton stacker eliminated round balers above the 3 dollar wage rate. A study of these figures should help farmers select from among the several systems one for their adoption.

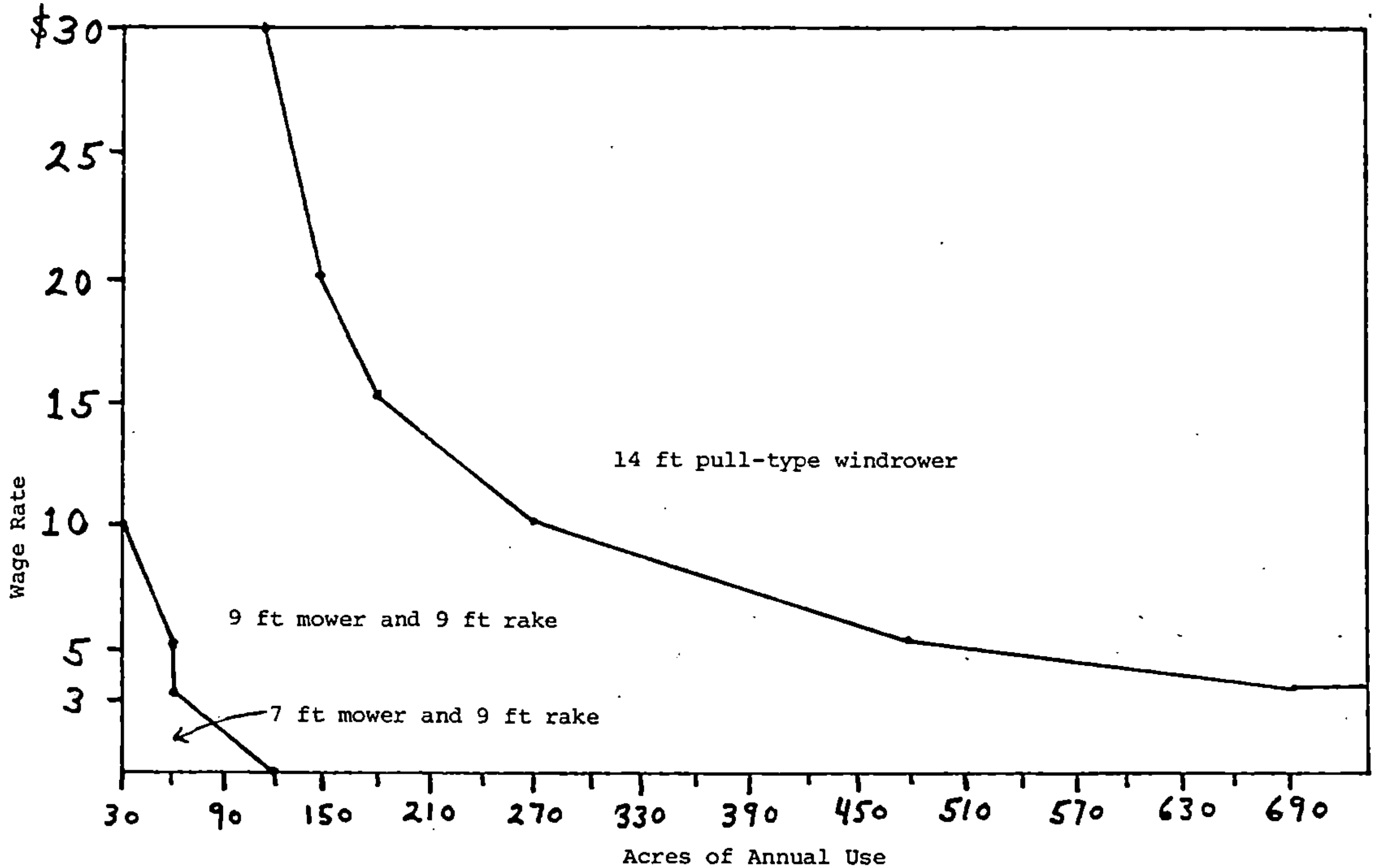

Figure 2. Least-cost systems for cutting and windrowing hay at given acres of annual use (acreage times number of harvests) with varying wage rates

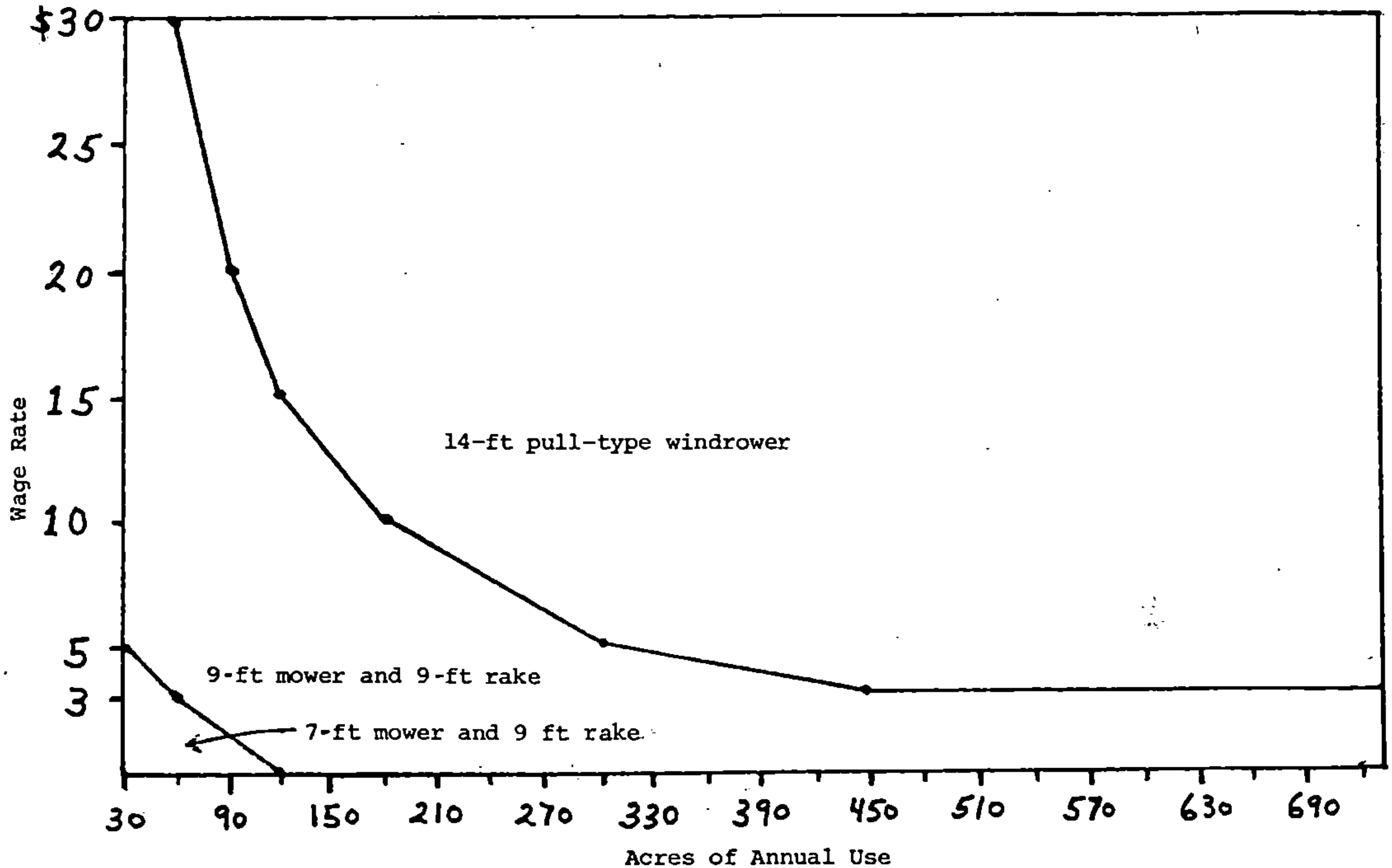

Figure 3. Least-cost systems (net of tax savings) for cutting and windrowing hay at given acres of annual use (acreage times number of harvests) with varying wage rates

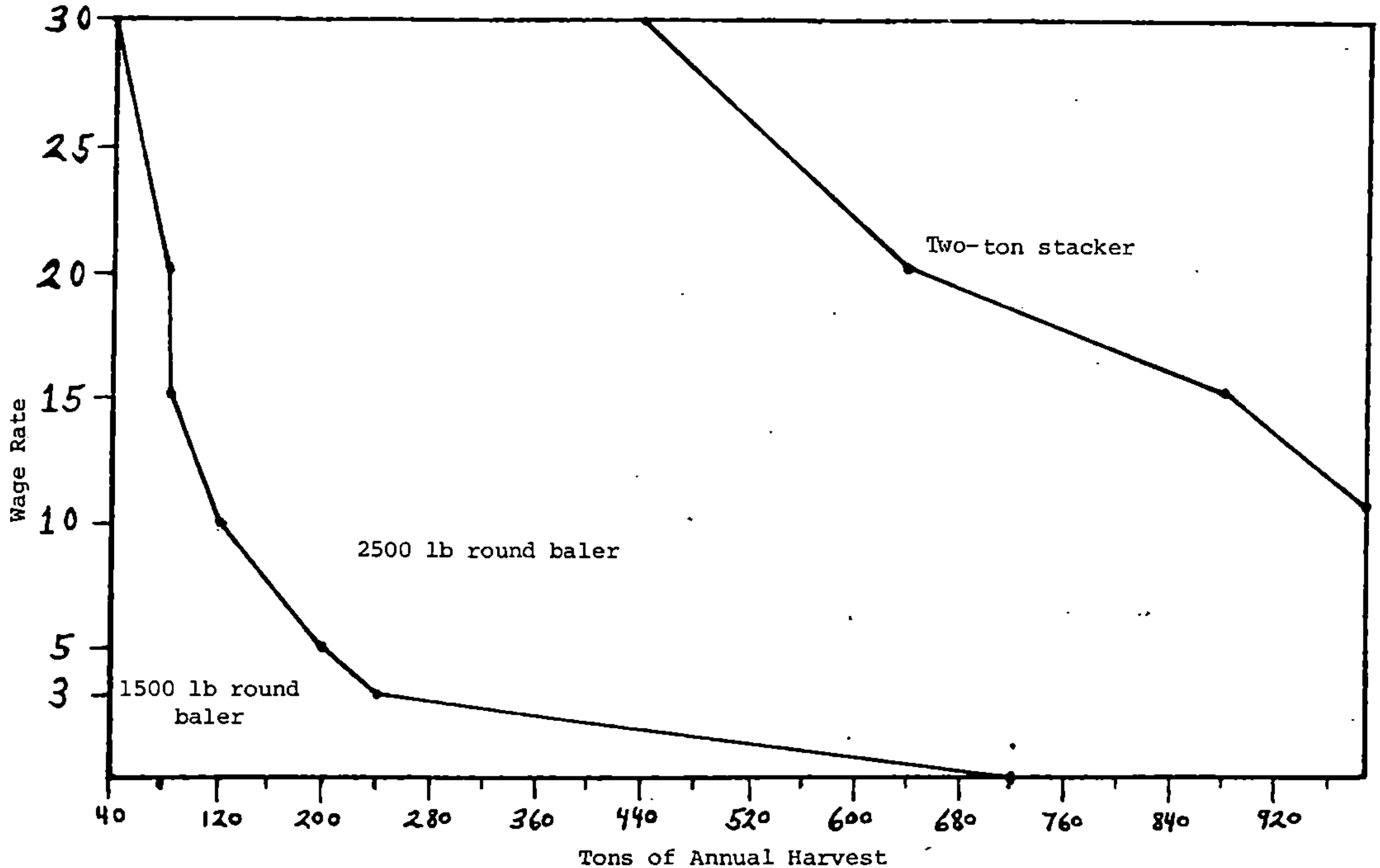

Figure 4. Least-cost systems for packaging, hauling, and feeding hay at given tons of annual harvest with varying wage rates, comparing all six packaging systems

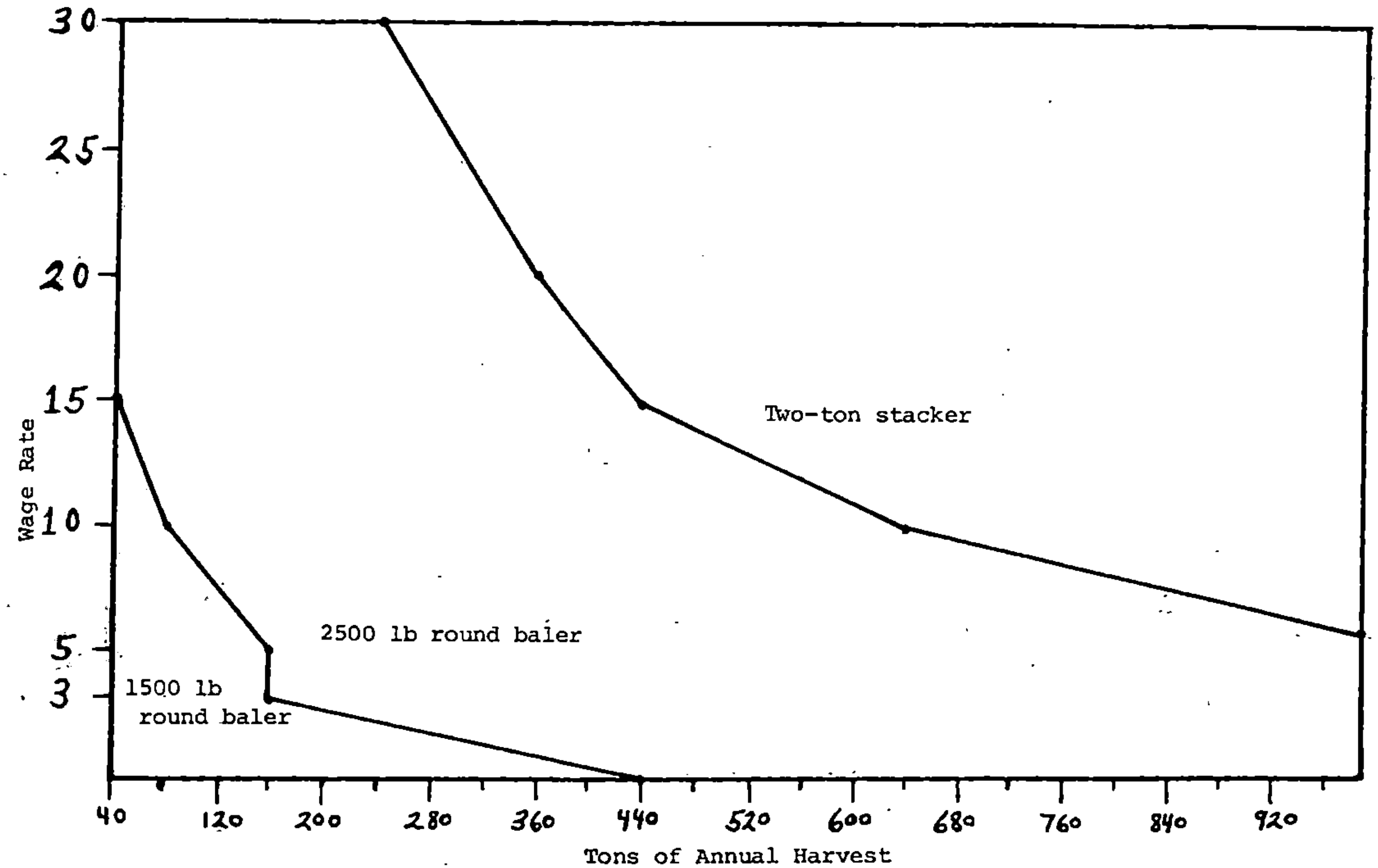

Figure 5. Least-cost systems (net of taxing savings) for packaging, hauling, and feeding hay at given tons of annual harvest with varying wage rates, comparing all six packaging systems

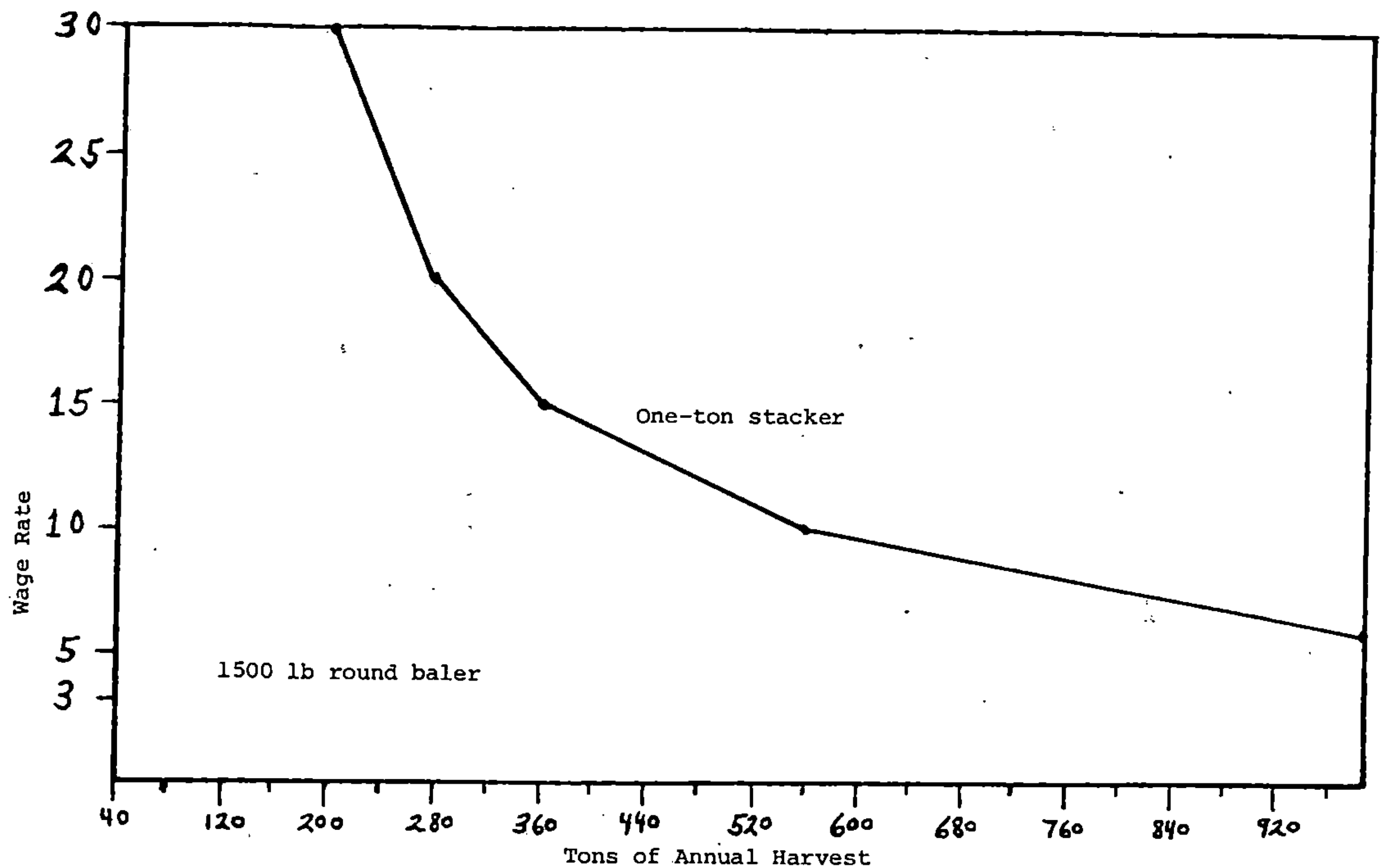

Figure 6. Least-cost systems for packaging, hauling, and feeding hay at given tons of annual harvest with varying wage rates, comparing conventional square balers, 1500 lb round baler, and one-ton stacker systems

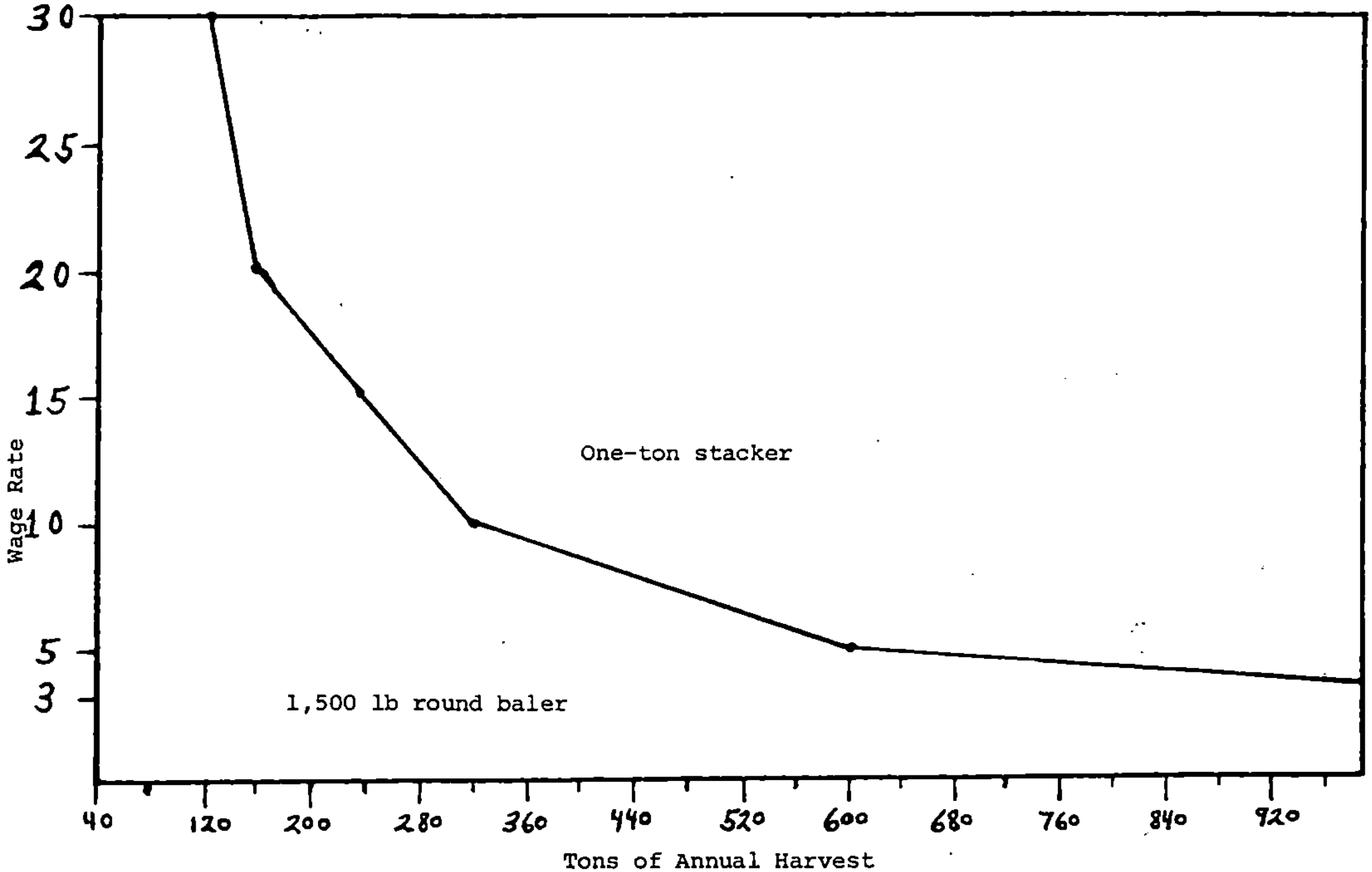

Figure 7. Least-cost systems (net of tax savings) for packaging, hauling, and feeding hay at given tons of annual harvest with varying wage rates, comparing conventional square balers, 1,500 lb round baler, and one-ton stacker systems

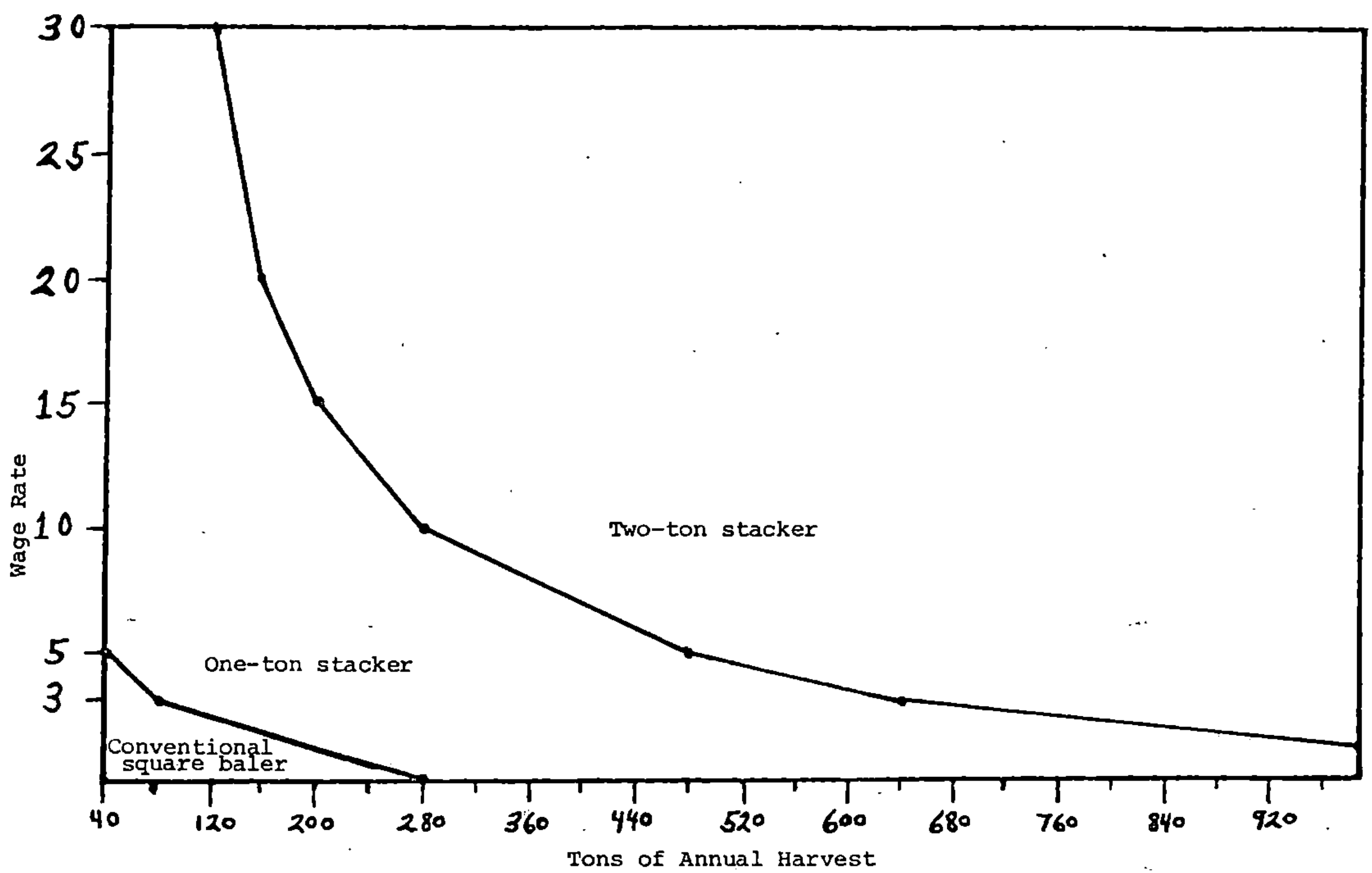

Figure 8. Least-cost systems for packaging, hauling, and feeding hay at given tons of annual harvest with varying wage rates, comparing conventional square baler, one-ton stacker, and two-ton stacker systems

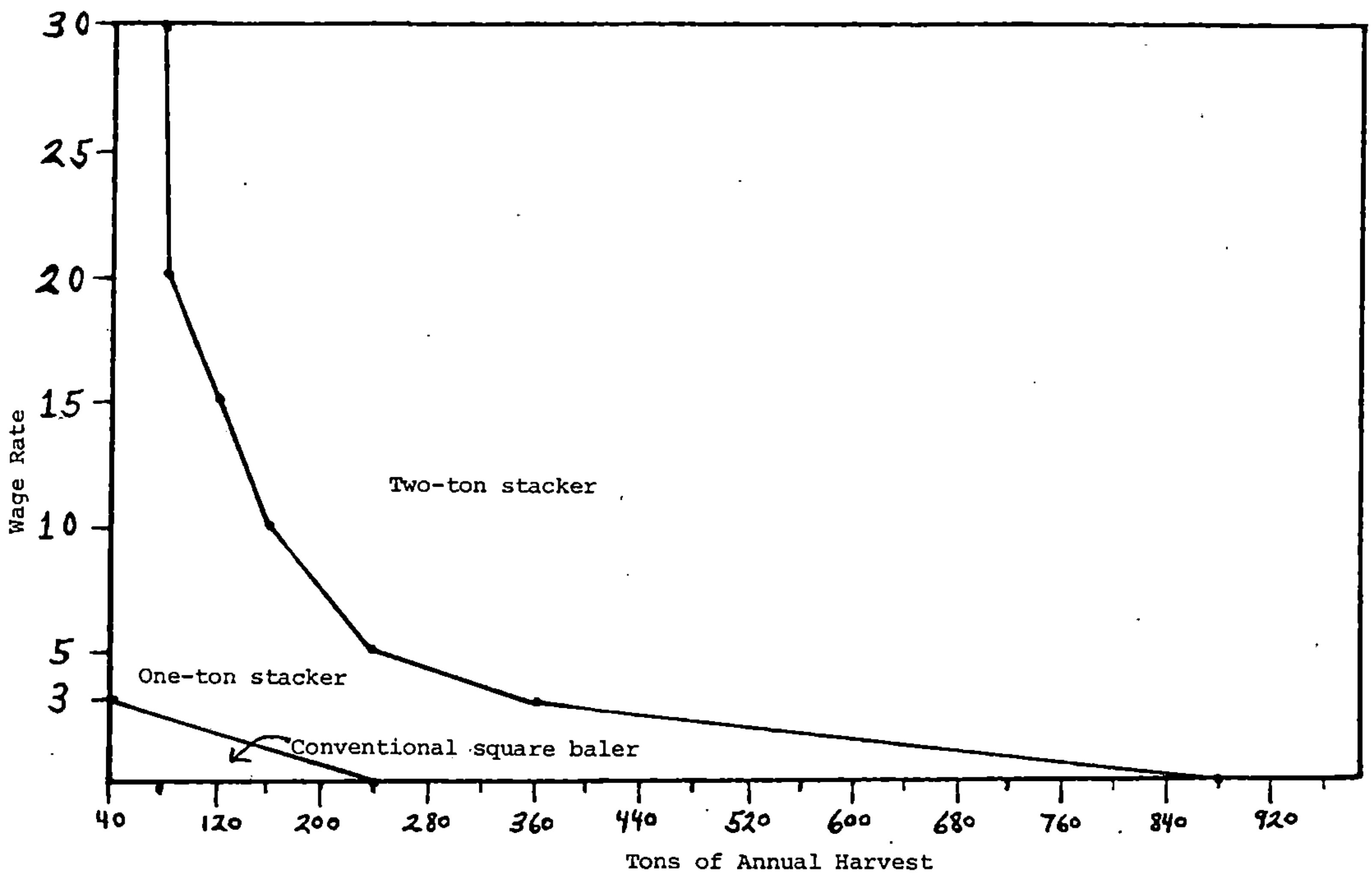

Figure 9. Least-cost systems (net of tax savings) for packaging, hauling, and feeding hay at given tons of annual harvest with varying wage rates, comparing conventional square baler, one-ton stacker, and two-ton stacker systems

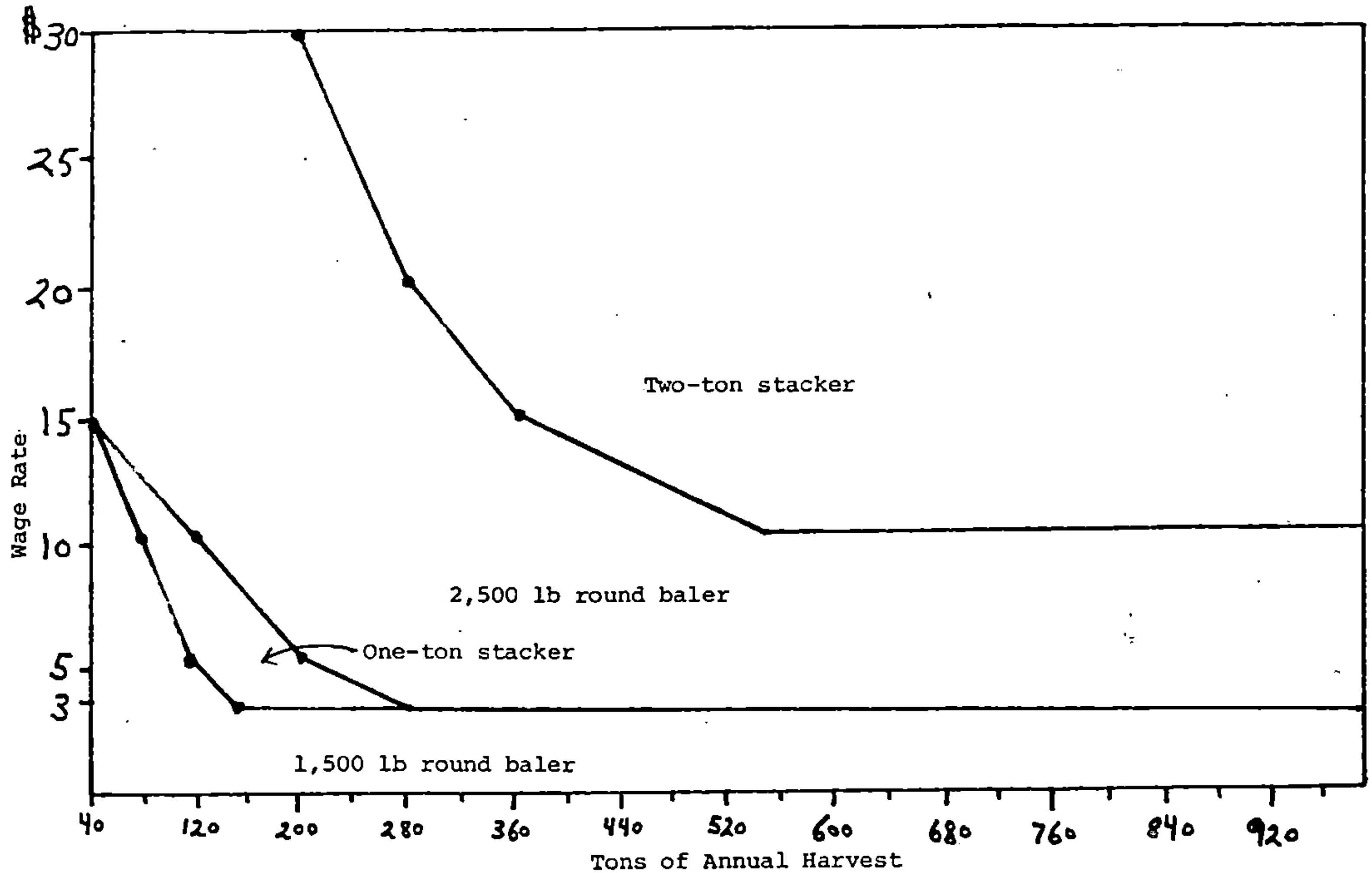

Figure 10. Least-cost systems for packaging, hauling, and feeding hay at given tons of annual harvest with varying wage rates, comparing stackers that are used 67 percent for hay with all other systems

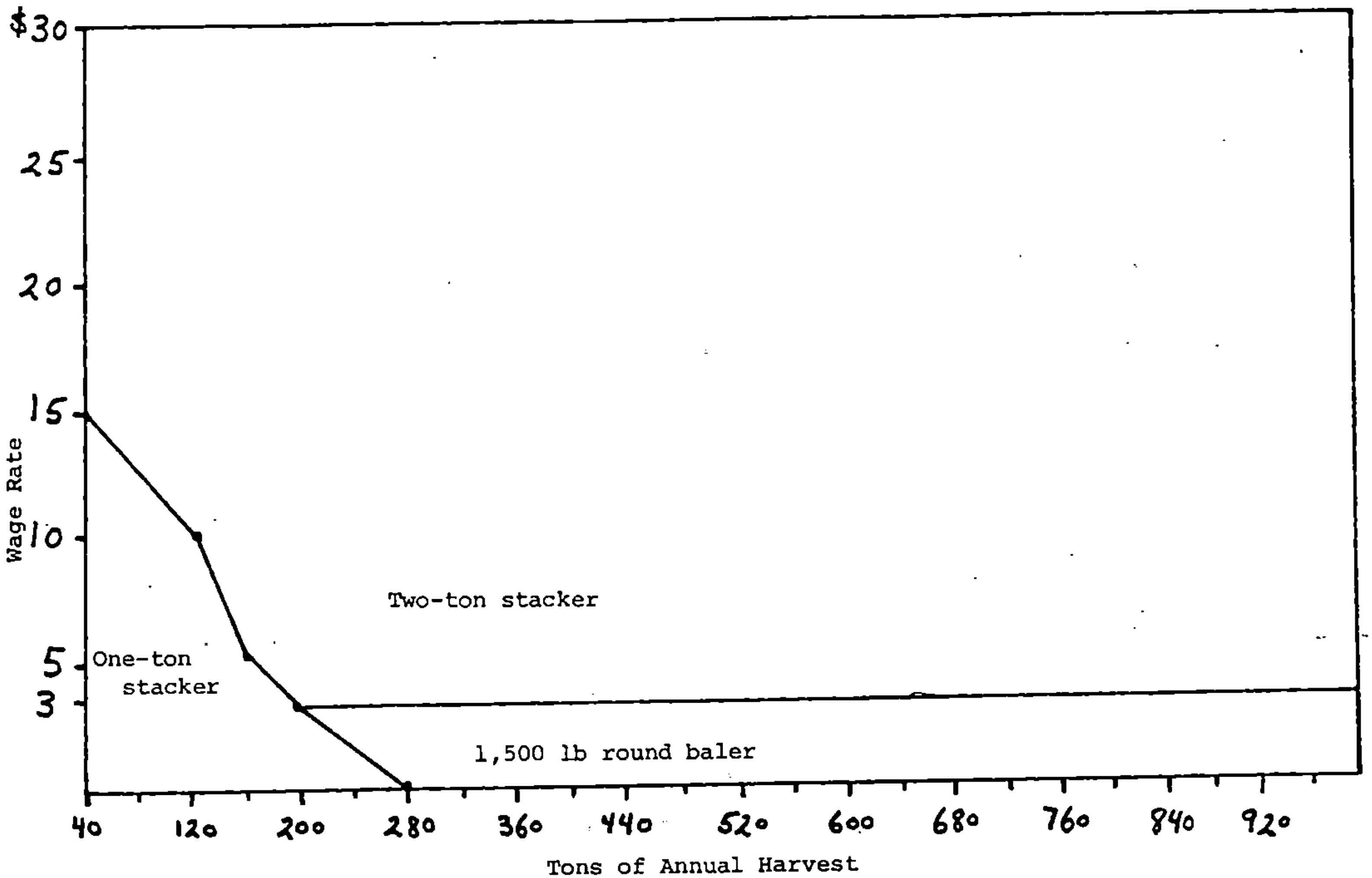

Figure 11. Least-cost systems (net of tax savings) for packaging, hauling, and feeding hay at given tons of annual harvest with varying wage rates, comparing stackers that are used 67 percent for hay with all other systems

V. Conclusions

The trend toward large-package forage harvesting machinery and windrowers is readily apparent to anyone traveling across the forage-producing regions of Iowa. The cost analysis of this study indicated that large-package forage harvesting systems and windrowers are competitive with conventional hay harvesting systems on Iowa farms. This study verified the economic wisdom of the current haying machinery purchase decisions being made by many Iowa farmers. The economic advantages and popularity of large-package machines and windrowers will continue to grow as fuel and labor costs rise, farm workers become more scarce, and large-package management techniques improve.

The opportunity cost of labor was shown to have a strong effect in determining the least-cost system. Even at the $3 wage rate, the new large-package systems clearly dominated all but the very low tonnage levels. As wage rates rose, the heavier weight package systems became least-cost at lower and lower tonnage levels.

The 1,500 lb. round baler system was least-cost over conventional systems for all wage rates and usage levels. The 2,500 round baler was least-cost over the 1,500 lb. round baler at 240 tons of annual use for the $3 labor cost, and became least-cost at 120 tons for a $10 labor cost. At a labor cost of $15, the two-ton stacker became least-cost over the 2,500 lb. round baler at 880 tons of annual use, but at a $20 labor cost the two-ton stacker was least cost at 640 tons of annual use. The 14 ft. pull-type windrower was least-cost at 480 acres of use for a $5 labor opportunity cost, at 270 acres of use for a $10 labor opportunity cost, and at 180 acres of use for a $15 labor opportunity cost.

Tax savings from investment makes the more expensive larger capacity package systems least-cost at lower levels of use. With tax savings, the 2,500 lb. round baler was least cost at 160 tons of annual use for a $3 labor cost. The two-ton stacker became least cost over the 2,500 lb. round baler at 640 tons of annual use for a $10 labor cost when tax savings were deducted.

With tax savings, the 14 ft. pull-type windrower was least cost at 180 acres of use (60 acres harvested three times) for a $10 labor opportunity cost.

The cost analysis indicated that the large-package forage systems are superior over conventional square bale systems in most farm situations, except those where annual tons of hay harvested and wage rates are very low. (This assumes hay sales are not greatly affected by package type.) Conventional balers using mechanical bale throwers and hired storage workers may be competitive if the opportunity cost of the operator's labor which is needed to move large packages is high.

While the cost advantage of large-package systems over conventional small-bale systems was significant, the differences in costs and benefits between large-package systems were often small. There may not be a great advantage in choosing the optimal machine compared to the next best alternative. When evaluating costs and comparing differences, one must make certain that the appropriate opportunity cost of labor is used. When the true difference in costs is known, a judgment can be made as to whether additional considerations might suggest a choice other than the least cost or income maximizing optimum.

Physical advantages of the different sizes of large packages should be carefully considered. The analyses favored the 2,500 lb. round bales and two-ton stacks, but manufacturer information and the interviews showed a preference for the 1,500 lb. round bales and one-ton stacks. The corn stover harvesting ability of stackers may be another important consideration. The cost effects of stover feed give advantage to stackers over balers, particularly if custom stover harvesting services are not available or if the beef herd is large.

In an application of these costs to a farm situation not reported here it was shown that the choice of cutting and windrowing equipment may be more important than the choice of packaging machinery. In the cost analysis, the 14 ft. pull-type windrower had a sizeable cost savings over mower and rake systems for annual use levels over 150 acres (50 acres harvested three times) and labor opportunity costs over $15 per hour. In the whole farm analysis, the income benefit from a 14 ft. windrower over a 9 ft. mower and rake was greater than the income benefit of the optimal packaging machine over the least desirable package machine. Windrowers can save two-thirds the time required by a mower and rake system.

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Appendix A: Input Data for Determining Farm Machinery Costs

Table A1. Large-package machines evaluated in the study

Manufacturer	Model	Package Size	Package Weight
		Large Round Bales	
Venmeer	504C	5 ft dia. x 4 ft	1000 lbs
	605C	6 ft dia. x 5 ft	1500 lbs
	706C	7 ft dia. x 6 ft	2500 lbs
Hesston	5400	5 ft dia. x 5 ft	1000 lbs
	5800	6 ft dia. x 5 ft	1500 lbs
International Harvester	241	6 ft dia. x 5 ft	1500 lbs
Gehl	1500A	6 ft dia. x 5 ft	1500 lbs
John Deere	500	6 ft dia. x 5 ft	1500 lbs
Massey-Ferguson	450	5 ft dia. x 4 ft	1000 lbs
	560	6 ft dia. x 5 ft	1500 lbs
New Holland	850	5 1/2 ft dia. x 5 1/2 ft	1200 lbs
		Large Stackers	
Hesston	StakHand 10	7 x 8 x 8 ft	1 ton
	StakHand 30A	8 x 14 x 9 ft	3 ton
	StakHand 60A	8 x 20 x 11 ft	6 ton
John Deere	100	8 1/2 x 10 x 8 ft	1 1/4 ton
	200	8 1/2 x 14 x 10 ft	4 ton
	300	8 1/2 x 21 x 10 ft	6 ton
Farmhand	300	9 x 20 1/2 x 8 ft	3 ton

Table A2. Total accumulated repair cost equations[a] (7)

4.	$TAR = ILP \times 0.50 \times 0.000631 \times L^{1.6}$
6.	$TAR = ILP \times 1.80 \times 0.00251 \times L^{1.3}$
7.	$TAR = ILP \times 0.85 \times 0.00251 \times L^{1.3}$
9.	$TAR = ILP \times 1.00 \times 0.00251 \times L^{1.3}$
10.	$TAR = ILP \times 0.65 \times 0.000251 \times L^{1.8}$
11.	$TAR = ILP \times 1.00 \times 0.000251 \times L^{1.8}$

[a]There are 11 such equations; listed here are only those used in this study. The general form of the equation is: total accumulated repairs = initial list price x RC1 x RC2 x L^{RC3}.

Table A3. The total accumulated repair cost equation numbers and the wear out life for farm machinery (7)

Machine	TAR Equation Number	Wear out Life in Hours
Forage Stacker	4	2,000
Large Round Baler	7	2,000
Conventional Square Baler	7	2,000
Cutterbar Mowers	6	1,000
S.P. Windrowers, mower-conditioners	9	1,500
Side-delivery Rakes	9	2,000
Flat-rack Wagons	11	5,000
Bale Elevators	10	1,000
Bale and Stack Mowers	4	2,500

Table A4. Price, tractor size and power requirements for machines in the study

Machine	Price ($)	Tractor Size PTO Horsepower	Power Needed PTO Horsepower[a]
1,500 lb round baler	5,200	120 hp	45 hp
2,500 lb round baler	6,700	120 hp	60 hp
One-ton stacker	7,400	120 hp	40 hp
Two-ton stacker	11,500	120 hp	60 hp
Square baler	4,350	60 hp	30 hp
Square baler/thrower	5,500	60 hp	45 hp
7 ft mower	1,100	60 hp	30 hp
9 ft mower	1,250	60 hp	25 hp
10 ft Mower-conditioner	4,500	60 hp	25 hp
12 ft Mower-conditioner	6,700	70 hp	50 hp
14 ft pull-type windrower	6,900	70 hp	55 hp
12 ft self-propelled windrower	11,000	65 hp	65 hp
14 ft self-propelled windrower	11,400	65 hp	65 hp
Side-delivery rake	1,250	60 hp	36 hp
Flat wagon (two)	1,600	70 hp	-
Racked flat wagon (two)	2,000	70 hp	-
Bale elevator	800	electric	-
1,500 lb bale mower	180	70 hp	-
2,500 lb baler mower	1,000	95 hp	-
One-ton 3 pt stack mower	750	95 hp	-
One-ton trailer stack mower	1,230	60 hp	-
Two-ton stack mower	3,150	70 hp	-

[a]Machines withcut a given needed PTO horsepower used ASAE average fuel consumption method.

Table A5. Operations, performance rates, and workers required for cost analysis

Operation	Tons Per Hr	Workers Required
Mowing - 7 ft mower	4.5	1
Mowing - 9 ft mower	6.0	1
10 ft mower-conditioner	6.7	1
12 ft pull-type windrower	8.2	1
14 ft pull-type windrower	9.6	1
12 ft self-propelled windrower	9.7	1
14 ft self-propelled windrower	11.2	1
Raking	9.4	1
Baling - square baler	5.0	2
Baling - square baler with thrower	5.25	1
Hauling from field square bales and unload	5 to 5.25	3
Stacking hay - 1 ton stacker	5	1
Stacking hay - 2 ton stacker	8	1
Baling - 1,500 round baler	9	1
Baling - 2,500 round baler	12.5	1
Storing 1 ton stacks		
Central	4	1
Field	6	1
Storing 2 ton stacks		
Central	8	1
Field	12	1

Appendix B. Machinery Costs

Table B1. Costs per acre for cutting, conditioning, and raking of hay. Wage rate $5.00 per hour.

Acres per year	Hours of annual use	Costs per acre: Annual repair	Total variable	Total fixed	Total	Total costs/acre net of tax savings — Method of depreciation: St. Line	Decl. Bal.	S. of D.
				7-Foot Mower				
30	8.82	0.27	2.17	6.38	8.54	6.38	6.24	6.25
60	17.65	0.34	2.23	3.19	5.42	4.34	4.27	4.27
90	26.47	0.38	2.27	2.13	4.40	3.68	3.63	3.64
120	35.29	0.42	2.31	1.59	3.90	3.36	3.33	3.33
180	52.94	0.47	2.36	1.06	3.42	3.06	3.04	3.04
240	70.59	0.51	2.40	0.80	3.20	2.93	2.91	2.91
300	88.24	0.55	2.44	0.64	3.08	2.86	2.85	2.85
450	132.35	0.62	2.51	0.43	2.94	2.79	2.78	2.78
600	176.47	0.67	2.57	0.32	2.89	2.78	2.77	2.77
				9-Foot Mower				
30	6.67	0.21	1.65	6.99	8.64	6.27	6.12	6.13
60	13.33	0.26	1.70	3.50	5.19	4.00	3.93	3.94
90	20.00	0.29	1.73	2.33	4.06	3.27	3.22	3.22
120	26.67	0.32	1.76	1.75	3.50	2.91	2.87	2.88
180	40.00	0.36	1.80	1.17	2.96	2.57	2.54	2.54
240	53.33	0.39	1.83	0.87	2.70	2.41	2.39	2.39
300	66.67	0.42	1.86	0.70	2.56	2.32	2.30	2.30
450	100.00	0.47	1.91	0.47	2.38	2.22	2.21	2.21
600	133.33	0.51	1.95	0.35	2.30	2.18	2.18	2.18
				9-Foot Side-Delivery Rake				
30	6.38	0.04	1.44	6.99	8.43	6.06	5.91	5.92
60	12.77	0.05	1.45	3.50	4.95	3.76	3.69	3.69
90	19.15	0.06	1.46	2.33	3.79	3.00	2.95	2.95
120	25.53	0.07	1.46	1.75	3.21	2.62	2.58	2.58
180	38.30	0.08	1.47	1.17	2.64	2.24	2.22	2.22
240	51.06	0.08	1.48	0.87	2.35	2.06	2.04	2.04
300	63.83	0.09	1.48	0.70	2.18	1.95	1.93	1.93
450	95.74	0.10	1.50	0.47	1.96	1.80	1.79	1.79
600	127.66	0.11	1.50	0.35	1.85	1.74	1.73	1.73
				10-Foot Mower Conditioner				
30	6.00	0.20	1.46	29.02	30.48	19.71	18.98	19.29
60	12.00	0.24	1.51	14.51	16.02	10.63	10.27	10.42
90	18.00	0.27	1.54	9.67	11.21	7.62	7.38	7.48
120	24.00	0.30	1.56	7.25	8.82	6.13	5.94	6.02
180	36.00	0.34	1.60	4.84	6.44	4.64	4.52	4.57
240	48.00	0.37	1.63	3.63	5.26	3.91	3.82	3.86
300	60.00	0.39	1.66	2.90	4.56	3.48	3.41	3.44
450	90.00	0.44	1.71	1.93	3.64	2.93	2.88	2.90
600	120.00	0.48	1.75	1.45	3.20	2.66	2.63	2.64

Table B1. (continued)

Acres per year	Hours of annual use	Costs per acre: Annual repair	Total variable	Total fixed	Total	Total costs/acre net of tax savings — Method of depreciation: St. Line	Decl. Bal.	S. of D.
				12-Foot Pull-Type Windrower				
30	4.84	0.22	1.34	43.20	44.54	28.51	27.42	27.89
60	9.68	0.27	1.39	21.60	22.99	14.98	14.43	14.67
90	14.52	0.31	1.43	14.40	15.83	10.48	10.12	10.28
120	19.35	0.34	1.46	10.80	12.26	8.25	7.98	8.09
180	29.03	0.38	1.50	7.20	8.70	6.03	5.85	5.92
240	38.71	0.41	1.53	5.40	6.93	4.93	4.79	4.85
300	48.39	0.44	1.56	4.32	5.88	4.28	4.17	4.22
450	72.58	0.50	1.62	2.88	4.50	3.43	3.36	3.39
600	96.77	0.55	1.66	2.16	3.82	3.02	2.97	2.99
				14-Foot Pull-Type Windrower				
30	4.17	0.19	1.17	44.49	45.66	29.15	28.02	28.51
60	8.33	0.23	1.21	22.25	23.46	15.20	14.64	14.88
90	12.50	0.26	1.24	14.83	16.07	10.57	10.19	10.35
120	16.67	0.29	1.26	11.12	12.39	8.26	7.98	8.10
180	25.00	0.32	1.30	7.42	8.72	5.96	5.78	5.86
240	33.33	0.35	1.33	5.56	6.89	4.83	4.69	4.75
300	41.67	0.38	1.35	4.45	5.80	4.15	4.04	4.09
450	62.50	0.42	1.40	2.97	4.37	3.27	3.19	3.23
600	83.88	0.46	1.44	2.22	3.67	2.84	2.78	2.81
				12-Foot Self-Propelled Windrower				
30	4.11	0.29	1.44	70.93	72.37	46.04	44.25	45.03
60	8.22	0.36	1.51	35.47	36.97	23.81	22.92	23.30
90	12.33	0.41	1.56	23.63	25.20	16.42	15.83	16.09
120	16.44	0.45	1.59	17.73	19.32	12.74	12.30	12.49
180	24.66	0.50	1.65	11.82	13.47	9.08	8.79	8.91
240	32.88	0.55	1.70	8.87	10.56	7.27	7.05	7.14
300	41.10	0.59	1.73	7.09	8.83	6.19	6.02	6.09
450	61.64	0.66	1.81	4.73	6.54	4.78	4.66	4.72
600	82.19	0.72	1.87	3.55	5.42	4.10	4.01	4.05
900	123.29	0.82	1.96	2.36	4.33	3.45	3.39	3.42
				14-Foot Self-Propelled Windrower				
30	4.11	0.31	1.45	73.51	74.96	47.68	45.82	46.63
60	8.22	0.38	1.52	36.75	38.28	24.63	23.71	24.11
90	12.33	0.42	1.57	24.50	26.07	16.98	16.36	16.63
120	16.44	0.46	1.61	18.38	19.99	13.16	12.70	12.90
180	24.66	0.52	1.67	12.25	13.92	9.37	9.06	9.20
240	32.88	0.57	1.72	9.19	10.90	7.49	7.26	7.36
300	41.10	0.61	1.75	7.35	9.11	6.38	6.19	6.27
450	61.64	0.69	1.83	4.90	4.73	4.92	4.79	4.85
600	82.19	0.75	1.90	3.68	5.57	4.21	4.11	4.15
900	123.29	0.85	1.99	2.45	4.44	3.53	3.47	3.50

Table B2. Costs per ton for packaging dry forages.[a/] Wage rate $5.00 per hour.

Tons per year	Hours of annual use	Cost per ton: Annual repair	Total variable	Total fixed	Total	Total costs/ton net of tax savings, Method of depreciation: St. Line	Decl. Bal.	S. of D.
			Conventional Square Baler					
40	8.00	0.13	3.72	18.98	22.70	16.19	16.11	16.79
80	16.00	0.16	3.75	9.49	13.24	9.99	9.95	9.79
120	24.00	0.18	3.77	6.33	10.10	7.93	7.90	7.80
160	32.00	0.20	3.79	4.74	8.53	6.91	6.89	6.81
200	40.00	0.22	3.80	3.80	7.60	6.30	6.28	6.22
400	80.00	0.26	3.85	1.90	5.75	5.10	5.09	5.06
600	120.00	0.30	3.89	1.27	5.15	4.72	4.71	4.69
800	160.00	0.33	3.91	0.95	4.86	4.54	4.53	4.52
			Conventional Square Baler with Bale Thrower					
40	7.62	0.16	2.64	23.16	25.80	17.91	17.48	17.44
80	15.24	0.19	2.68	11.58	14.26	10.31	10.10	10.08
120	22.86	0.22	2.70	7.72	10.42	7.79	7.65	7.64
160	30.48	0.24	2.72	5.79	8.51	6.54	6.43	6.42
200	38.10	0.26	2.74	4.63	7.37	5.79	5.71	5.70
400	76.19	0.31	2.80	2.32	5.12	4.33	4.28	4.28
600	114.29	0.35	2.84	1.54	4.38	3.86	3.83	3.83
800	152.38	0.39	2.87	1.16	4.03	3.64	3.61	3.61
			1,500-Pound Round Baler					
40	4.44	0.07	1.29	22.69	23.98	16.21	16.11	15.73
80	8.89	0.09	1.31	11.34	12.65	8.77	8.72	8.53
120	13.33	0.10	1.32	7.56	8.88	6.29	6.26	6.13
160	17.78	0.11	1.33	5.67	7.00	5.06	5.04	4.94
200	22.22	0.12	1.34	4.54	5.88	4.32	4.30	4.23
400	44.44	0.15	1.37	2.27	3.64	2.86	2.85	2.81
600	66.67	0.17	1.39	1.51	2.90	2.38	2.37	2.35
800	88.89	0.18	1.40	1.13	2.53	2.15	2.14	2.12
			2,500-Pound Round Baler					
40	3.20	0.06	0.91	29.23	30.13	20.12	20.00	19.50
80	6.40	0.08	0.92	14.61	15.53	10.53	10.46	10.22
120	9.60	0.09	0.93	9.74	10.67	7.33	7.29	7.13
160	12.80	0.09	0.94	7.31	8.24	5.74	5.71	5.59
200	16.00	0.10	0.94	5.85	6.79	4.79	4.76	4.66
400	32.00	0.12	0.97	2.92	3.89	2.89	2.88	2.83
600	48.00	0.14	0.98	1.95	2.93	2.26	2.26	2.22
800	64.00	0.15	1.00	1.46	2.46	1.96	1.95	1.93
1000	80.00	0.16	1.01	1.17	2.18	1.77	1.77	1.75

[a/] For stackers only it was assumed that they could be used for packaging hay and/or corn stover. Thus, three tabulations were made for each machine size. One is for hay only assuming no stover harvested. One is for hay tons assuming that one-third of the use is for corn stover packaging. And, one is for corn stover tons assuming that two-thirds of the use is for hay packaging.

Table B2. (continued)

Tons per year	Hours of annual use	Cost per ton: Annual repair	Cost per ton: Total variable	Cost per ton: Total fixed	Total	Total costs/ton net of tax savings, Method of depreciation: St. Line	Decl. Bal.	S. of D.
				One-Ton Stacker, Hay Only				
40	8.00	0.05	1.47	32.28	33.75	22.69	22.56	22.01
80	16.00	0.07	1.50	16.14	17.64	12.11	12.04	11.77
120	24.00	0.09	1.52	10.76	12.28	8.59	8.55	8.36
160	32.00	0.11	1.53	8.07	9.61	6.84	6.81	6.67
200	40.00	0.13	1.55	6.46	8.01	5.79	5.77	5.66
400	80.00	0.19	1.62	3.23	4.84	3.74	3.72	3.67
600	120.00	0.25	1.67	2.15	3.82	3.08	3.07	3.04
800	160.00	0.29	1.72	1.61	3.33	2.78	2.77	2.74
				Two-Ton Stacker, Hay Only				
40	5.00	0.04	0.98	50.17	51.15	33.96	33.75	32.90
80	10.00	0.05	1.00	25.08	26.08	17.49	17.38	16.96
120	15.00	0.07	1.01	16.72	17.73	12.00	11.93	11.65
160	20.00	0.08	1.02	12.54	13.57	9.27	9.22	9.00
200	25.00	0.09	1.04	10.03	11.07	7.63	7.59	7.42
400	50.00	0.14	1.08	5.02	6.10	4.38	4.36	4.28
600	75.00	0.18	1.12	3.34	4.47	3.32	3.31	3.25
800	100.00	0.21	1.16	2.51	3.66	2.81	2.79	2.75
1000	125.00	0.24	1.19	2.01	3.19	2.51	2.50	2.46
				One-Ton Stacker, Hay Only, Two-Thirds of Total				
40	8.00	0.06	1.48	21.63	23.11	12.05	11.92	11.37
80	16.00	0.09	1.52	10.81	12.33	6.80	6.73	6.46
120	24.00	0.12	1.54	7.21	8.75	5.07	5.02	4.84
160	32.00	0.14	1.56	4.51	6.97	4.21	4.17	4.04
200	40.00	0.16	1.58	4.33	5.91	3.70	3.67	3.56
400	80.00	0.24	1.67	2.16	3.83	2.73	2.71	2.66
600	120.00	0.31	1.74	1.44	3.18	2.44	2.43	2.39
800	160.00	0.37	1.79	1.08	2.88	2.32	2.32	2.29
				Two-Ton Stacker, Hay Only, Two-Thirds of Total				
40	5.00	0.05	0.99	33.61	34.60	17.41	17.20	16.36
80	10.00	0.07	1.01	16.81	17.82	9.22	9.12	8.69
120	15.00	0.09	1.03	11.20	12.23	6.50	6.43	6.15
160	20.00	0.10	1.05	8.40	9.45	5.15	5.10	4.89
200	25.00	0.12	1.06	6.72	7.78	4.35	4.30	4.13
400	50.00	0.18	1.12	3.36	4.48	2.76	2.74	2.66
600	75.00	0.23	1.17	2.24	3.41	2.27	2.25	2.20
800	100.00	0.27	1.21	1.68	2.89	2.04	2.02	1.98

Table B2. (continued)

Tons per year	Hours of annual use	Cost per ton: Annual repair	Cost per ton: Total variable	Cost per ton: Total fixed	Total	Total costs/ton net of tax savings, Method of depreciation: St. Line	Decl. Bal.	S. of D.
One-Ton Stacker, Corn Stover Only, One-Third of Total								
40	10.00	0.13	1.91	10.65	12.57	1.51	1.37	0.37
80	20.00	0.20	1.98	5.33	7.31	1.78	1.71	1.44
120	30.00	0.26	2.04	3.55	5.59	1.90	1.86	1.68
160	40.00	0.31	2.09	2.66	4.75	1.99	1.95	1.82
200	50.00	0.35	2.13	2.13	4.26	2.05	2.02	1.91
400	100.00	0.53	2.31	1.07	3.38	2.27	2.26	2.21
600	150.00	0.68	2.46	0.71	3.17	2.43	2.43	2.39
800	200.00	0.81	2.59	0.53	3.12	2.57	2.56	2.54
Two-Ton Stacker, Corn Stover Only, One-Third of Total								
40	6.67	0.11	1.37	16.56	17.92	0.73	0.52	0.32
80	13.33	0.17	1.42	8.28	9.70	1.11	1.00	0.58
120	20.00	0.21	1.47	5.52	6.99	1.26	1.19	0.90
160	26.67	0.25	1.51	4.14	5.65	1.35	1.30	1.08
200	33.33	0.29	1.54	3.31	4.85	1.42	1.37	1.21
400	66.67	0.43	1.69	1.66	3.35	1.63	1.61	1.52
600	100.00	0.55	1.81	1.10	2.91	1.77	1.75	1.70
800	133.33	0.66	1.92	0.83	2.74	1.88	1.87	1.83

Table B3. Costs per ton for storing hay.[a/] Wage rate $5.00 per hour.

Tons per year	Hours of annual use	Cost per ton: Annual repair	Cost per ton: Total variable	Cost per ton: Total fixed	Total	Total costs/ton net of tax savings, Method of depreciation: St. Line	Decl. Bal.	S. of D.
			Conventional Square Baler System					
40	16.00	0.01	3.41	6.83	10.24	6.79	6.61	6.59
80	32.00	0.03	3.42	3.42	6.84	5.11	5.02	5.00
120	48.00	0.04	3.43	2.27	5.71	4.56	4.50	4.49
160	64.00	0.05	3.44	1.71	5.15	4.28	4.24	4.23
200	80.00	0.05	3.46	1.37	4.81	4.12	4.09	4.09
400	160.00	0.10	3.49	0.68	4.18	3.83	3.82	3.81
600	240.00	0.14	3.53	0.45	3.99	3.76	3.75	3.75
800	320.00	0.17	3.57	0.34	3.91	3.74	3.73	3.73
			Conventional Square Baler System with Thrower					
40	15.24	0.01	3.25	7.67	10.92	6.89	6.69	6.66
80	30.48	0.03	3.26	3.84	7.09	5.08	4.98	4.97
120	45.72	0.04	3.27	2.55	5.83	4.49	4.41	4.40
160	60.96	0.04	3.28	1.92	5.19	4.19	4.14	4.13
200	76.20	0.05	3.29	1.54	4.83	4.02	3.97	3.97
400	152.38	0.10	3.33	0.77	4.10	3.70	3.68	3.67
600	228.58	0.14	3.36	0.51	3.88	3.61	3.60	3.59
800	304.76	0.17	3.40	0.38	3.78	3.58	3.57	3.57
			1500-Pound Round Bales at Field Edge					
40	8.33	0.00	1.43	0.39	1.83	1.56	1.56	1.54
80	16.67	0.00	1.44	0.20	1.63	1.50	1.50	1.49
120	25.00	0.00	1.44	0.13	1.57	1.48	1.48	1.47
160	33.33	0.00	1.44	0.10	1.53	1.47	1.47	1.46
200	41.67	0.00	1.44	0.08	1.52	1.46	1.46	1.46
400	83.33	0.01	1.44	0.04	1.48	1.45	1.45	1.45
600	125.00	0.01	1.44	0.03	1.47	1.45	1.45	1.45
800	166.67	0.01	1.44	0.02	1.46	1.45	1.45	1.45
			2500-Pound Round Bales at Field Edge					
40	5.00	0.00	0.86	2.18	3.04	1.55	1.53	1.46
80	10.00	0.00	0.87	1.09	1.96	1.21	1.20	1.16
120	15.00	0.01	0.87	0.73	1.59	1.10	1.09	1.06
160	20.00	0.01	0.87	0.55	1.41	1.04	1.03	1.02
200	25.00	0.01	0.87	0.44	1.31	1.01	1.00	0.99
400	50.00	0.01	0.87	0.22	1.09	0.94	0.94	0.93
600	75.00	0.02	0.88	0.15	1.02	0.92	0.92	0.92
800	100.00	0.02	0.88	0.11	0.99	0.91	0.91	0.91
1000	125.00	0.02	0.88	0.09	0.97	0.91	0.91	0.91

[a/] It was assumed that all small square bales were moved to the farmstead and stored in shelters. All large round bales and stacks were stored in the open, some around the perifery of the production fields and some moved to the farmstead site.

Table B3. (continued)

Tons per year	Hours of annual use	Cost per ton: Annual repair	Cost per ton: Total variable	Cost per ton: Total fixed	Total	Total costs/ton net of tax savings, Method of depreciation: St. Line	Decl. Bal.	S. of D.
1500-Pound Round Bales in Central Yard								
40	12.50	0.00	2.15	0.39	2.55	2.28	2.27	2.26
80	25.00	0.00	2.15	0.20	2.35	2.22	2.21	2.21
120	37.50	0.00	2.16	0.13	2.29	2.20	2.20	2.19
160	50.00	0.01	2.16	0.10	2.25	2.19	2.19	2.08
200	62.50	0.01	2.16	0.08	2.24	2.18	2.18	2.18
400	125.00	0.01	2.16	0.04	2.20	2.17	2.17	2.17
600	187.50	0.01	2.16	0.03	2.19	2.17	2.17	2.17
800	250.00	0.02	2.17	0.02	2.19	2.17	2.17	2.17
2500-Pound Round Bales in Central Yard								
40	7.41	0.01	1.28	2.18	3.46	1.97	1.95	1.88
80	14.81	0.01	1.28	1.09	2.37	1.63	1.62	1.58
120	22.22	0.01	1.29	0.73	2.01	1.52	1.51	1.48
160	29.63	0.01	1.29	0.55	1.83	1.46	1.46	1.44
200	37.04	0.02	1.29	0.44	1.73	1.43	1.42	1.41
400	74.07	0.02	1.30	0.22	1.52	1.37	1.37	1.36
600	111.11	0.03	1.31	0.15	1.45	1.35	1.35	1.35
800	148.15	0.04	1.31	0.11	1.42	1.35	1.34	1.34
1000	185.19	0.04	1.32	0.09	1.40	1.34	1.34	1.34
One-Ton Stacks at Field Edge with Three-Point Hitch Mover								
40	6.67	0.00	1.23	1.66	2.87	1.75	1.73	1.68
80	13.33	0.01	1.24	0.82	2.05	1.49	1.49	1.46
120	20.00	0.01	1.24	0.55	1.78	1.41	1.40	1.39
160	26.67	0.01	1.24	0.41	1.65	1.37	1.36	1.35
200	33.33	0.01	1.24	0.33	1.57	1.34	1.34	1.33
400	66.67	0.02	1.24	0.16	1.41	1.30	1.29	1.29
600	100.00	0.02	1.25	0.11	1.36	1.28	1.28	1.28
800	133.33	0.02	1.25	0.08	1.33	1.28	1.28	1.27
One-Ton Stacks at Field Edge with Trailer-Type Mover								
40	6.67	0.01	1.12	2.68	3.80	1.96	1.94	1.85
80	13.33	0.01	1.12	1.34	2.47	1.55	1.53	1.49
120	20.00	0.01	1.13	0.89	2.02	1.41	1.40	1.37
160	26.67	0.01	1.13	0.67	1.80	1.34	1.33	1.31
200	33.33	0.02	1.13	0.54	1.67	1.30	1.30	1.28
400	66.67	0.03	1.14	0.27	1.41	1.22	1.22	1.21
600	100.00	0.03	1.15	0.18	1.33	1.20	1.20	1.20
800	133.33	0.04	1.15	0.13	1.29	1.19	1.19	1.19

Table B3. (continued)

Tons per year	Hours of annual use	Cost per ton: Annual repair	Cost per ton: Total variable	Cost per ton: Total fixed	Total	Total costs/ton net of tax savings, Method of depreciation: St. Line	Decl. Bal.	S. of D.
				Two-Ton Stacks at Field Edge with Mover				
40	3.33	0.01	0.58	6.87	7.45	2.74	2.68	2.45
80	6.67	0.01	0.58	3.44	4.02	1.66	1.63	1.52
120	10.00	0.01	0.58	2.29	2.87	1.30	1.29	1.21
160	13.33	0.01	0.59	1.72	2.30	1.13	1.11	1.05
200	16.67	0.01	0.59	1.37	1.96	1.02	1.01	0.96
400	33.33	0.02	0.59	0.69	1.28	0.81	0.81	0.78
600	50.00	0.03	0.60	0.46	1.06	0.74	0.74	0.73
800	66.67	0.03	0.61	0.34	0.95	0.71	0.71	0.70
				One-Ton Stacks to Central Yard with Three-Point Hitch Mover				
40	10.00	0.01	1.85	0.64	3.49	2.37	2.35	2.30
80	20.00	0.01	1.85	0.82	2.67	2.11	2.11	2.08
120	30.00	0.01	1.86	0.55	2.40	2.03	2.03	2.01
160	40.00	0.02	1.86	0.41	2.27	1.99	1.99	1.97
200	50.00	0.02	1.86	0.33	2.19	1.97	1.96	1.95
400	100.00	0.03	1.87	0.16	2.04	1.92	1.92	1.92
600	150.00	0.04	1.88	0.11	1.99	1.92	1.91	1.91
800	200.00	0.04	1.89	0.08	1.97	1.91	1.91	1.91
				One-Ton Stacks in Central Yard with Trailer-Type Mover				
40	10.00	0.01	1.68	2.68	4.37	2.53	2.50	2.41
80	20.00	0.02	1.69	1.34	3.03	2.11	2.10	2.06
120	30.00	0.02	1.69	0.89	2.59	1.98	1.97	1.94
160	40.00	0.03	1.70	0.67	2.37	1.91	1.90	1.88
200	50.00	0.03	1.70	0.54	2.24	1.87	1.87	1.85
400	100.00	0.05	1.72	0.27	1.99	1.80	1.80	1.79
600	150.00	0.06	1.73	0.18	1.91	1.79	1.79	1.78
800	200.00	0.07	1.74	0.13	1.88	1.79	1.79	1.78
				Two-Ton Stacks in Central Yard with Mover				
40	5.00	0.01	0.87	6.87	7.74	3.03	2.97	2.74
80	10.00	0.02	0.88	3.44	4.31	1.96	1.93	1.81
120	15.00	0.02	0.88	2.29	3.17	1.60	1.58	1.50
160	20.00	0.02	0.88	1.72	2.60	1.42	1.41	1.35
200	25.00	0.03	0.89	1.37	2.26	1.32	1.31	1.26
400	50.00	0.04	0.90	0.69	1.59	1.12	1.11	1.09
600	75.00	0.05	0.91	0.46	1.37	1.06	1.05	1.04
800	100.00	0.06	0.92	0.34	1.27	1.03	1.03	1.02
1000	125.00	0.07	0.93	0.27	1.21	1.02	1.02	1.01

Table B4. Costs per ton for feeding dry forages.[a] Wage rate $5.00 per hour.

Tons per year	Hours of annual use	Cost per ton: Annual repair	Total variable	Total fixed	Total	Total costs/ton net of tax savings, Method of depreciation: St. Line	Decl. Bal.	S. of D.
				Small Square Bales				
40	50.00	0.00	7.76	3.34	11.10	8.84	8.69	8.71
80	100.00	0.00	7.76	1.67	9.43	8.30	8.22	8.24
120	150.00	0.00	7.76	1.11	8.88	8.12	8.07	8.08
160	200.00	0.00	7.76	1.84	8.60	8.03	7.99	8.00
200	250.00	0.00	7.76	0.67	8.43	7.98	7.95	7.95
400	500.00	0.00	7.76	0.33	8.09	7.87	7.85	7.86
600	750.00	0.00	7.76	0.22	7.98	7.83	7.82	7.82
800	1000.00	0.00	7.76	0.17	7.93	7.81	7.81	7.81
				1500-Pound Round Bales				
40	17.39	0.00	3.00	0.39	3.39	3.12	3.12	3.10
80	34.78	0.01	3.00	0.20	3.19	3.06	3.06	3.05
120	52.17	0.01	3.00	0.13	3.13	3.04	3.04	3.04
160	69.57	0.01	3.00	0.10	3.10	3.03	3.03	3.03
200	86.96	0.01	3.00	0.08	3.08	3.03	3.03	3.02
400	173.91	0.02	3.01	0.04	3.05	3.02	3.02	3.02
600	260.87	0.02	3.01	0.03	3.04	3.02	3.02	3.02
800	347.83	0.03	3.02	0.02	3.04	3.02	3.02	3.02
				2500-Pound Round Bales				
40	10.53	0.01	1.82	2.18	4.00	2.51	2.49	2.42
80	21.05	0.02	1.83	1.09	2.92	2.17	2.16	2.12
120	31.58	0.02	1.83	0.73	2.56	2.06	2.05	2.03
160	42.11	0.02	1.84	0.55	2.38	2.01	2.00	1.98
200	52.63	0.03	1.84	0.44	2.28	1.98	1.97	1.96
400	105.26	0.04	1.85	0.22	2.07	1.92	1.92	1.91
600	157.89	0.05	1.87	0.15	2.01	1.91	1.91	1.91
800	210.53	0.06	1.88	0.11	1.98	1.91	1.91	1.91
1000	263.16	0.07	1.89	0.09	1.97	1.91	1.91	1.91
				One-Ton Stacks with Three-Point Hitch				
40	13.33	0.01	2.47	1.64	4.11	2.99	2.97	2.92
80	26.67	0.02	2.48	0.82	3.29	2.73	2.73	2.70
120	40.00	0.02	2.48	0.55	3.03	2.65	2.65	2.63
160	53.33	0.03	2.49	0.41	2.89	2.61	2.61	2.60
200	66.67	0.03	2.49	0.33	2.82	2.59	2.59	2.58
400	133.33	0.05	2.51	0.16	2.67	2.56	2.56	2.55
600	200.00	0.06	2.52	0.11	2.63	2.55	2.55	2.55
800	266.67	0.07	2.53	0.08	2.61	2.56	2.55	2.55

[a] All small square bales were fed on the ground and all large round bales and stacks were fed in a moveable rack designed for their use.

Table B4. (continued)

Tons per year	Hours of annual use	Cost per ton: Annual repair	Cost per ton: Total variable	Cost per ton: Total fixed	Total	Total costs/ton net of tax savings, Method of depreciation: St. Line	Decl. Bal.	S. of D.
One-Ton Stacks with Trailer-Type Mover								
40	13.33	0.02	2.25	2.68	4.93	3.09	3.07	2.98
80	26.67	0.03	2.26	1.34	3.60	2.68	2.67	2.62
120	40.00	0.04	2.27	0.89	3.16	2.55	2.54	2.51
160	53.33	0.04	2.27	0.67	2.94	2.48	2.48	2.46
200	66.67	0.05	2.28	0.54	2.82	2.45	2.44	2.43
400	133.33	0.08	2.30	0.27	2.57	2.39	2.39	2.38
600	200.00	0.10	2.33	0.18	2.50	2.38	2.38	2.37
800	266.67	0.12	2.34	0.13	2.48	2.39	2.39	2.38
Two-Ton Stacks with Mover								
40	8.00	0.02	1.40	6.87	8.27	3.56	3.50	3.27
80	16.00	0.03	1.41	3.44	4.84	2.49	2.46	2.35
120	24.00	0.04	1.42	2.29	3.71	2.14	2.12	2.04
160	32.00	0.05	1.43	1.72	3.14	1.97	1.95	1.89
200	40.00	0.06	1.43	1.37	2.81	1.87	1.85	1.81
400	80.00	0.09	1.46	0.69	2.15	1.68	1.67	1.65
600	120.00	0.11	1.49	0.46	1.95	1.63	1.63	1.61
800	160.00	0.13	1.51	0.34	1.85	1.62	1.61	1.60
1000	200.00	0.15	1.53	0.27	1.80	1.61	1.61	1.60

Table B5. Costs per ton for packaging, storing, and feeding hay.[a/] Wage rate $5.00 per hour.

Tons per year	Hours of annual use	Cost per ton: Annual repair	Cost per ton: Total variable	Cost per ton: Total fixed	Total	Total costs/ton net of tax savings, Method of depreciation: St. Line	Decl. Bal.	S. of D.
				Conventional Square Baler System				
40	74.00	0.14	14.89	29.15	44.04	31.82	31.41	31.09
80	148.00	0.19	14.93	14.58	29.51	23.40	23.19	23.03
120	222.00	0.22	14.96	9.71	24.69	20.61	20.47	20.37
160	296.00	0.25	14.99	7.29	22.28	19.22	19.12	19.04
200	370.00	0.27	15.02	5.84	20.84	18.40	18.32	18.26
400	740.00	0.36	15.10	2.91	18.02	16.80	16.76	16.73
600	1110.00	0.44	15.18	1.94	17.12	16.31	16.28	16.26
800	1480.00	0.50	15.24	1.46	16.70	16.09	16.07	16.06
				Conventional Baler with Thrower System				
40	72.86	0.17	13.65	34.07	47.82	33.64	32.86	32.81
80	145.72	0.22	13.70	17.09	30.78	23.69	23.30	23.29
120	218.58	0.26	13.73	11.38	25.13	20.40	20.13	20.12
160	291.44	0.28	13.76	8.55	22.30	18.76	18.56	18.55
200	364.30	0.31	13.79	6.84	20.63	17.79	17.63	17.62
400	728.57	0.41	13.89	3.42	17.31	15.90	15.81	15.81
600	1092.87	0.49	13.96	2.27	16.24	15.30	15.25	15.24
800	1457.14	0.56	14.03	1.71	15.74	15.03	14.99	14.99
				1500-Pound Round Baler System, Central Storage				
40	34.33	0.07	6.44	23.47	29.92	21.61	21.50	21.09
80	68.67	0.10	6.46	11.47	18.19	14.05	13.99	13.79
120	103.00	0.11	6.48	7.82	14.30	11.53	11.50	11.36
160	137.35	0.13	6.49	5.87	12.35	10.28	10.26	10.15
200	171.68	0.14	6.50	4.70	11.20	9.53	9.51	9.43
400	343.35	0.18	6.54	2.35	8.89	8.05	8.04	8.00
600	515.03	0.20	6.56	1.57	8.13	7.57	7.56	7.54
800	686.72	0.23	6.59	1.17	7.76	7.34	7.33	7.31
				2500-Pound Round Baler System, Central Storage				
40	21.14	0.08	4.01	33.59	37.59	24.60	24.44	23.80
80	42.26	0.11	4.03	16.79	20.82	14.33	14.24	13.92
120	63.40	0.12	4.05	11.20	15.24	10.91	10.85	10.64
160	84.54	0.12	4.07	8.41	12.45	9.21	9.17	9.01
200	105.67	0.15	4.07	6.73	10.80	8.20	8.15	8.03
400	211.33	0.18	4.12	3.36	7.48	6.18	6.17	6.10
600	317.00	0.22	4.16	2.25	6.39	5.52	5.52	5.48
800	422.68	0.25	4.19	1.68	5.86	5.22	5.20	5.18
1000	528.35	0.27	4.22	1.35	5.55	5.02	5.02	5.00

[a/] Assumptions were the same as specified for Tables B1 to B4.

Table B5. (continued)

Tons per year	Hours of annual use	Cost per ton: Annual repair	Cost per ton: Total variable	Cost per ton: Total fixed	Total	Total costs/ton net of tax savings, Method of depreciation: St. Line	Decl. Bal.	S. of D.
One-Ton Stacker System, Central Storage								
40	31.33	0.07	5.79	35.56	41.35	28.05	27.88	27.23
80	62.67	0.10	5.83	17.78	23.60	16.95	16.88	16.55
120	94.00	0.12	5.86	11.86	17.71	13.27	13.23	13.00
160	125.33	0.16	5.88	8.89	14.77	11.44	11.41	11.24
200	156.67	0.18	5.90	7.12	13.02	10.34	10.32	10.19
400	313.33	0.27	6.00	3.55	9.55	8.22	8.20	8.14
600	470.00	0.35	6.07	2.37	8.44	7.55	7.53	7.50
800	626.67	0.40	6.14	1.77	7.91	7.25	7.23	7.20
Two-Ton Stacker System, Central Storage								
40	18.00	0.07	3.25	63.91	67.16	40.55	40.22	38.91
80	36.00	0.10	3.29	31.96	35.23	21.94	21.77	21.12
120	54.00	0.13	3.31	21.30	24.61	15.74	15.63	15.19
160	72.00	0.15	3.33	15.98	19.31	12.66	12.58	12.24
200	90.00	0.18	3.36	12.77	16.14	10.82	10.75	10.49
400	180.00	0.27	3.44	6.40	9.84	7.18	7.14	7.02
600	270.00	0.34	3.52	4.26	7.79	6.01	5.99	6.90
800	360.00	0.40	3.59	3.19	6.78	5.46	5.43	5.37
1000	450.00	0.46	3.65	2.55	6.20	5.14	5.13	5.07